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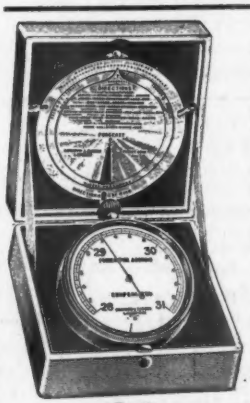

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The first SESSION will open on TUESDAY, OCTOBER 5, 1920, and Courses of Study in preparation for Degrees in Pure and Applied Science of the University of Wales will be provided in the above Departments.

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The post carries an initial salary of £E42 per annum plus bonus, which consists of an increase of 20% to salary and in addition a war gratuity of 60% on the salary so improved, provided that the increase from the war gratuity does not exceed £E192 per annum, and that the total increase from both sources of increment does not exceed £E300 per annum. The Pound Egyptian is worth about sixpence more than the Pound Sterling.

Applications, together with statements of qualifications and references, which will be received up to August 15, 1920, should be endorsed "Arboriculturist, Egyptian Ministry of Agriculture," and addressed to Sir ARTHUR WEBB, K.C.M.G., Queen Anne's Chambers, Broadway, Westminster, from whom all particulars regarding conditions of service, etc., can be obtained.

THURSDAY, AUGUST 5, 1920.

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University Grants.

A FEW weeks ago (June 17, p. 477) reference was made in these columns to the financial position of the Universities and institutions of University rank, and a plea was put forward for more adequate Government financial support. We are not unmindful that the Government has already recognised that it has responsibilities in this respect, but we greatly doubt whether it has fully realised their extent. The majority of these institutions are of comparatively recent foundation, and from the first have led a precarious existence; restricted resources and even poverty have almost uniformly been their lot. Nevertheless, they have ministered to the needs of higher education in a truly remarkable way; they have helped this country to hold its own in the face of world competition, and materially contributed to its success in the Great War. This being so, one would think that the encouragement and development of higher education would be among the first and primary cares of the Government. While we believe that this really is the intention, yet, if we may judge from certain proposals recently made, the Government does not fully appreciate the present state of affairs in the Universities. Apart from the question of new and additional accommodation due to the great influx of students, and altogether apart from the necessities of internal development which are yearly becoming more and more insistent, there stand out the dominant facts that the great body of University teachers are quite inadequately remunerated, and that there are no really practicable sources which can be tapped to provide proper and adequate emoluments for them. It is within our knowledge that the present economic position is pressing most severely upon a large number of University teachers, and that the financial position of many Universities is precarious.

If there is one thing more than another which has been insistently pressed upon the University Grants Committee on its visitations—and, we are glad to say, has uniformly received a sympathetic hearing—it is this question of inadequate remuneration. A University is essentially a corporation of men and women, and if the teaching side of this corporation is dissatisfied or labours under a sense of injustice, its work loses its spontaneity and efficiency, and the interests of higher education, and with them those of the nation, will suffer in consequence. Obviously this is a truism which need not be laboured. When men and women have to eke out inadequate stipends by extraneous work the effects, though almost imperceptible at first, are bound to be serious in the long run. But this is not all. Inadequate remuneration reacts unfavourably upon the supply of efficient teachers. Talented young students will look elsewhere for their life's work. Already, as we have indicated on a previous occasion, the financial inducements of industry have depleted the Universities of some of their ablest teachers, and there are no uncertain indications that this depletion is likely to become more serious still.

Now, the Chancellor of the Exchequer recognises that the Government must do more, and he proposes to ask Parliament to increase the Treasury grant-in-aid from 1,000,000*l.* to 1,500,000*l.* in the Estimates for 1921–22. He does not propose to ask for any supplementary grant this year. We respectfully submit that this proposal is totally inadequate. As a matter of fact, we would point out that Parliament is not to be asked for a larger sum than is given this year; what is proposed is simply to make the non-recurrent 500,000*l.* recurrent. We repeat that such a sum is totally inadequate for present needs. A recent statistical inquiry instituted by the Association of University Teachers has elicited the fact that the average salary at present paid to an assistant lecturer is 250*l.*; to a lecturer, 366*l.*; and to a professor, 800*l.*, from which, of course, must be deducted the superannuation premiums of 5 per cent. or so. When we consider the largely increased salaries paid to teachers in other branches of the profession, let alone the inducements offered in industry, it is obvious that such average salaries will not attract the right type of teacher to the University in the future. We repeat that the proposed grant-in-aid is absolutely inadequate under present economic conditions, and would respectfully urge upon the Chancellor of the Exchequer to reconsider the whole question.

If this is the case regarding the general financial

position, what must be said about the question of superannuation? A short time ago a deputation consisting of representatives of the governing bodies of the Universities and institutions of University rank in England and Wales, together with representatives of the Association of University Teachers, waited upon the Chancellor of the Exchequer to put before him certain proposals regarding the present unsatisfactory state of superannuation in the Universities. Briefly these proposals were to the effect that the Government should grant University teachers the same, or similar, superannuation benefits as already granted to other branches of the profession under the School Teachers (Superannuation) Act, 1918, *plus* certain other benefits which the University teachers were prepared to pay for themselves by an annual premium on their salaries. The deputation was a most representative one and absolutely unanimous in its proposals. We now understand that the Chancellor is "prepared to consider the advisability of proposing to Parliament a further non-recurrent sum to assist the Universities in meeting the grievance of those senior members who are precluded from profiting to the full by the benefits of the University Superannuation Scheme." At the same time, it is announced that the Council of the Federated Superannuation System of the Universities has undertaken to obtain the information upon which the proposed non-recurrent grant will be made.

In all this there is not a word about giving University teachers the same, or similar, privileges that school teachers have in their non-contributory Government scheme. Not a word about facilitating the transference of teachers from the schools to the Universities or from the Universities to the schools, so that there would be no loss of superannuation benefits on the transference. Not a word about full retrospective benefits, irrespective of whether the service has been in schools or in Universities. Not a word about the consequent unity of the teaching profession. It would seem that the policy is to make such transference as difficult as possible. Now, obviously such a policy cannot be in the interests of education. It may be that we have placed too narrow an interpretation upon the words quoted above. We hope so. For, unless we are profoundly mistaken, the great bulk of the University teachers will be bitterly disappointed if the Government does not at least grant them benefits equivalent to those already granted to 95 per cent. of the teaching profession in the country.

Tanks and Scientific Warfare.

Tanks in the Great War, 1914–1918. By Brevet-Col. J. F. C. Fuller. Pp. xxiv + 331 + vii plates. (London: John Murray, 1920.) Price 21*s*. net.

THIS remarkable book is a clear and straightforward history of how the British Army learnt to use the most revolutionary weapon the great war produced. It is written by a confirmed believer in that weapon, whose belief probably became more and more complete as the Tank Corps gradually grasped a few of the principles involved in its use. It is somewhat of a pity that the author does not devote a chapter to the process by which the Tank Corps arrived at the tactics which eventually proved so successful. It took something like two years to overcome the prejudices raised against tanks in official quarters, and this in war-time, when progress is relatively rapid compared with that in peace. It is therefore to be hoped that the principles so ably set forth by Col. Fuller, and so well proved in the late war, will never again be overlooked.

It is only natural that it took many months for the Tank Corps to evolve anything like effective tank tactics. Many methods had to be tested in battle before being discarded, and it is not unusual, but rather a matter for congratulation, if the tactics evolved for the battle of Hamel were primarily suggested by the Australians, for it serves to show the close co-operation obtained, and the openmindedness of those in the Tank Corps to adopt the suggestions of others.

The history of tank tactics is an instance of how an effective weapon may be entirely wasted unless its use is understood. As to how much blame attaches to the Tank Corps for the use of tanks in the Ypres salient and similar misuses up to the first battle of Cambrai the author is silent, nor does it matter much, except that it serves to show how necessary it is for the expert on the new weapon to have some say in such matters. However, if, as Col. Fuller says on p. 58, the following lessons were learnt as the result of the first use of tanks on the Somme in 1916, especially No. 2, then the later tank actions need a lot of explanation.

The battle of Cambrai, although it demonstrated what tanks in numbers over good ground and without a preliminary bombardment could do, yet would have been a far greater success had the tank tactics as finally adopted at the battle of Hamel been in use. There is no question that the town of Cambrai itself would have been taken on the first day of the attack had proper co-operation with the infantry been maintained. The

hold-up of tanks at Flesquières (p. 149) would not have taken place had the infantry been following the tanks closely, and could also have been got over by the tank crews getting out of their machines and stalking the field-gunner as infantry. The infantry on this occasion were several hundred yards behind!

This book makes one hope that someone will write the history of tanks from the civilian point of view. Read in conjunction with this excellent work, some of the more obvious mistakes in the past might thus be avoided in the future. It is now common knowledge that neither the War Office nor G.H.Q. welcomed "tanks," although it might be inferred from this book that they did so. The tank was fathered by the Navy, and had reached success before it was handed over. Its history was briefly as follows, and it is illuminating how little the Army contributed.

In Mr. Winston Churchill's letter to the Prime Minister of January, 1915, he remarks: "It is extraordinary that the Army in the field and the War Office should have allowed nearly three months of warfare to progress without addressing their minds to its special problems." It *was* extraordinary, and more so when they turned down any proposals made to them for breaking down the "trench warfare" into which both armies had settled. Mr. Winston Churchill made direct reference in this letter to armoured caterpillars and the way in which they should be employed.

There were many schemes put forward for carrying out this suggestion, but the successful one was produced by Major W. G. Wilson, who was then a lieutenant, R.N.V.R., in the Royal Naval Armoured Cars. Working in conjunction with Mr. (now Sir) William Tritton at the works of Messrs. Foster, of Lincoln, the machine was constructed and afterwards demonstrated at Hatfield. The designers called for a statement from the Army as to the width of trench to be crossed, height of parapet to be climbed, etc., and this was drawn up by Col. Swinton, who stands out at this time as practically the only champion tanks had in the Army.

Although the Navy fathered the production of the first tank, it was equally fortunate that after its success had been demonstrated at Hatfield to representatives from the War Office and G.H.Q., France, the future of tanks was entrusted to Sir Albert Stern. It was he who, when the first order for tanks was cancelled by the War Office, refused to cancel the order, and said he would, if necessary, pay for them himself.

Again, fate was kind to them on their first venture at the battle of the Somme. On September 15, 1916, two companies, each consisting of twenty-eight tanks, went into action. The company commanded by Major Summers got twenty-two machines into action, but only two of the other company crossed into No-man's Land. It is more than likely that, but for the efforts of Summers and his technical officer, Knothe, tanks would have been voted a failure and never given another trial. It is worth noting that both these officers were, prior to the war, civilians

Again, it seems never to have been pointed out how the Army authorities failed to grasp the full importance of other proposals of the tank tribe. In 1916 the need of the moment was such protection against the machine-gun, but the early pioneers of the tank movement saw far greater possibilities in the caterpillar track. It was evident that roads and railways were the serious limiting factors to our armies. All supplies had to go by rail and road, and as these could be destroyed by the enemy's long-range artillery, the obvious need was for an alternative—something that could do without road or rails, and cross ploughed fields, shelled areas, hedges, and small rivers. The caterpillar track as used on tanks had been proved to be capable of doing this. Rightly or wrongly, the first attempt was made to design a caterpillar gun-carriage that would take a 5-in. gun or a 6-in. howitzer, or alternatively could be used to carry a large number of rounds of ammunition for either of these guns. It was designed so that the gun could be trained and fired from this movable platform, and the whole be capable of crossing shell-holes and trenches like the tank. The machine was tested at Shoeburyness, the gun being fired and trained with ease. Its value was never realised, and the scheme was allowed to drop. True, fifty machines of the first type were built, but nothing was ever made of the generic idea, and a second improved type, in which the faults of the first had been overcome, was allowed to lapse.

In the autumn of 1918 the value of a cross-country tractor was realised to the extent that many thousands were ordered here and in the U.S.A., but again "realisation" came too late, and none materialised.

As already stated, the Tank Corps insisted in interfering with design, with the result that progress and output were adversely affected. In numerous cases its wishes were followed, such as the change over from the Hotchkiss to the Lewis gun, the lengthening of the Mk. V. by 6 ft., the turning down of the G.C. Mk. II., and the Mk. IX. machine built to its requirements, and the results were, to say the least, serious.

However, Col. Fuller makes no comment on these points, but doubtless he would agree that in the future the Tank Corps in the field should confine itself to the problem of fighting the machine most effectively, and to giving the fullest possible information to the Headquarters Staff on which it may base its tactical requirements for the future classes of machines, these requirements to be conveyed to the designing department. How far such requirements can be met is for the designing and production departments to decide.

Much has been said about the use of tanks in small numbers at the battle of the Somme, and Col. Fuller is evidently of opinion that, had we held them back until large numbers were available, the element of surprise would have been so great as to have led to an overwhelming victory. The same might be said of the German use of gas for the first time against the Canadians. Personally, the present writer does not hold this view. A new weapon that is going to produce an overwhelming effect requires not only its use on a large scale, but also close co-operation with all other arms. This requires time and elaborate training, and training without the experience of actual battle is apt to be very misleading.

Mk. IV. tanks successfully took part in the decisive battles of the summer and autumn of 1918. It was this mark of machine that in 1917 the Tank Corps refused to accept, considering it useless. A little training in the proper way to fight with the new weapon had made all the difference. It was the Mk. IV. tank which carried out the brilliant operations with the Canadians in crossing the Canal du Nord in September, 1918 (see pp. 268-69). The officer in command of the Canadians after the battle sent for the officer in charge of these tanks and complimented him on the handling of the "new" type of tank and on the way in which all objectives were reached; the officer was silent, for they were the old Mk. IV. machines. The Mk. V. machine was a very great advance on the Mk. IV., but the greatest improvement of all was the realisation of how to use the new weapon in co-operation with the infantry.

Col. Fuller's book naturally deals chiefly with the fighting tank, and he clearly sets forth the claims of armour propelled by petrol as a protection and means of transport for the infantry against the machine-gun; but, as the author also points out, the German offensive of March, 1918, came to an end not so much on account of our resistance as because of the impossibility of bringing up artillery and supplies fast enough by the limited roads. The army of the future will be independent of roads and rails. Its artillery, supplies of shells, food, ambulances, etc., will be moved by petrol and caterpillar tracks.

The chapter on scientific warfare makes interesting reading. It might lead one to suppose that the wars of the future will be waged between small but highly trained armies, and that civilians will be carefully evacuated and safeguarded. The lesson of the late war seems to show that it will be impossible to protect civilians and increasingly difficult to discriminate between the trained warrior and women and children. The use of gas over large areas, of explosive dropped by aircraft, of huge tanks and tractors dashing over hill and dale, in their course passing over hamlets and villages, seems to make the lot of the non-combatant an unenviable one. Possibly this is all for the best, and certainly so if it acts as a deterrent to future wars.

In conclusion, one must say that the book is most excellent reading and remarkably free from controversy or axe-grinding. It has been said that the indication of the object of a war book can be got from the frontispiece. Many have a portrait of the writer, but this starts with a picture of the weapon which had such an effect on history, and the book is a valuable tribute to it (see p. 48).

Physiology of Farm Animals.

Physiology of Farm Animals. By T. B. Wood and Dr. F. H. A. Marshall. Part i. *General*. By Dr. F. H. A. Marshall. Pp. xii + 204. (Cambridge: At the University Press, 1920.) Price 16*s*. net.

SUCCESS in the rearing and feeding of animals depends to a large extent upon the practical application of the principles of physiology. Yet, although the breeding of farm animals and the production of meat and milk are of such great economic importance, the study of the physiology of farm animals has received comparatively little attention. The appearance of this text-book is, therefore, welcome. The reputation of the writers is likely to secure a wide use of the book in agricultural teaching centres.

The first volume deals with the general principles of physiology. It is lucidly written, and the illustrations are well chosen. The parts of the subject most fully treated are those which are of special practical importance, viz. the digestive system, the organs of locomotion, and the organs of reproduction. A clear account is given of the digestive system. The chapter on the organs of locomotion contains a very useful

description of the feet and legs of the horse, and the nature and causes of certain common ailments are indicated. The last two chapters, dealing with reproduction, are the best in the book. In addition to giving in a small compass and in an easily understood form all that is known of practical importance, they contain many suggestions that should be of great value to the breeder. A chapter on heredity would have added to the value of the book.

The other parts of the subject are dealt with more briefly, yet in sufficient detail to give the student of agriculture a working knowledge of the subject for all practical purposes.

In a few instances too little attention has been given to recent literature. The use of the term "amides" as covering the non-protein nitrogenous substance of feeding-stuffs is unfortunate. Although the term was used in this sense by certain of the older writers, it is no longer appropriate, since it is now known that the greater part of the non-protein nitrogenous substances consist of amino-acids, which, instead of being "of little importance as constituents of food," are as valuable as protein. The views put forward with regard to the metabolism of creatine and creatinine, which are largely those advanced by Mellanby some years ago, take no account of the work that has been done during the past ten or fifteen years. There is now no doubt that muscle, and not liver, is the chief seat of metabolism of both creatine and creatinine, and there is no experimental evidence in support of the view that creatine is formed from creatinine. The statement that creatine is found in the urine only in pathological conditions is scarcely correct, at least for farm animals. Creatine is found in the urine of the fowl, where it replaces creatinine, and it is a normal constituent of the urine of ruminants.

These, however, are points of minor importance so far as the student of agriculture is concerned. They are likely to be treated more fully in the second volume dealing with nutrition.

Chemical Text-books.

(1) *Laboratory Manual of Elementary Colloid Chemistry.* By Emil Hatschek. Pp. 135. (London: J. and A. Churchill, 1920.) Price 6*s.* 6*d.*

(2) *Chemistry for Public Health Students.* By E. Gabriel Jones. Pp. ix+244. (London: Methuen and Co., Ltd., 1920.) Price 6*s.* net.

(3) *Elementary Practical Chemistry. For Medical and other Students.* By Dr. J. E. Myers and J. B. Firth. Second edition, revised. (Griffin's Scientific Text-books.) Pp. viii+194. (London: Charles Griffin and Co., Ltd., 1920.) Price 4*s.* 6*d.*

(4) *Qualitative Analysis in Theory and Practice.* By Prof. P. W. Robertson and D. H. Burleigh. Pp. 63. (London: Edward Arnold, 1920.) Price 4*s.* 6*d.* net.

(5) *Practical Science for Girls: As Applied to Domestic Subjects.* By Evelyn E. Jardine. Pp. xiii+112. (London: Methuen and Co., Ltd., 1920.) Price 3*s.*

(6) *Acids, Alkalis, and Salts.* By G. H. J. Adlam. (Pitman's Common Commodities and Industries.) Pp. ix+112. (London: Sir Isaac Pitman and Sons, Ltd., n.d.) Price 2*s.* 6*d.* net.

(1) GRAHAM'S pioneer work on colloids is bearing rich fruit to-day, and colloid chemistry is becoming more and more important in theory and in practice. There are, of course, several text-books dealing with the subject generally, and giving descriptions of methods used in preparing colloidal substances. Mr. Hatschek himself is known as the author of one of these, and as the annotator of another, besides being the writer of a notable series of articles on colloids. There is, however, no laboratory manual similar to the present work. To expound the theory of the matter, lectures are good things, and books necessary; but the laboratory remains always the "forecourt of the temple" of colloid philosophy; it is only there that the student gains real familiarity with the characteristic properties of colloidal substances. And in the laboratory a well-devised series of practical exercises is invaluable for economising the worker's time, sparing his temper, and leading him to good results. The author's aim has therefore been to give "accurate and very detailed" directions for carrying out the fundamental operations. He is qualified to write a manual based upon personal experience of the special difficulties met with in the practice of this branch of chemistry, and he has done it very well. Both students and teachers have reason to be grateful to him.

(2) This, also, is essentially a laboratory guide. It is intended for students reading for the diploma in public health, and is therefore concerned generally with foodstuffs, water, alcoholic beverages, sewage effluents, air, and disinfectants. After two introductory chapters explaining the principles of gravimetric and volumetric analysis, the important foodstuffs milk, butter, and margarine are dealt with. Facts as to the chemical composition of these are given, and the legal enactments relating to the sale of them, together with the usual methods of analysis adopted. Then follow chapters on the other articles mentioned. Naturally in a book of only 240 pages some of the subjects

cannot be treated very fully. The information given, however, is accurate, and, whilst the book is readable, it is by no means superficial. Indeed, for a work of its scope it is substantial, and the reviewer has formed a very favourable opinion of it. One of the best sections is the chapter on air, but all are good. A number of examination questions are included.

(3) Dr. Myers and Mr. Firth's little book has become favourably known as a convenient introductory work on practical chemistry. The ground covered is elementary qualitative and quantitative analysis, including an outline of simple gas analysis, with methods for making "preparations" and for identifying the commoner organic compounds. It gives the requisite information concisely, and can be recommended as a suitable initiatory book for medical and pharmaceutical students.

(4) Messrs. Robertson and Burleigh's book is of a more advanced type than the foregoing. It treats of qualitative analysis only, but aims at giving the student a thorough grounding in this subject. The authors rightly hold that qualitative chemical analysis, intelligently taught, is of great value in laying a good foundation for a knowledge of the general chemistry of the metals and in illustrating the more important types of chemical reactions. Their method is to familiarise the student with these types (replacement, decomposition, oxidation, and reduction), and thus to enable him to see how they are applied to the problems of systematic analysis. They discard "dry" tests (apart from flame reactions) as being "tedious, often ambiguous, and misleading." They look with disfavour upon the practice of describing in detail, with equations, the individual reactions of the metals. The practice, they contend, is "pernicious and demoralising"; and the student, in the end, "simply copies into his notes what he sees in his text-book." It is by no means clear why this should be so. Surely it is the part of a capable teacher to find out, by a few suitable questions, whether a student really understands what the equations signify? If this is done there appears to be no particular objection to describing the individual reactions, and such a course simplifies the work of explanation. But be that as it may, there is no doubt that the student who works intelligently through the book under notice should obtain a good grasp of the matter. The questions propounded at the end of the sections will search out his weak points.

(5) This little book contains instructions for performing a series of simple exercises in physics, chemistry, and bacteriology. As occasion offers, the principles under discussion are applied to, or exemplified by, domestic subjects. Thus, having learned various methods of determining specific gravity, the student uses some of them to find the density of milk. In connection with thermometry she learns how to use a clinical thermometer. In the chemistry exercises she is taught how to make soap, how to remove stains from calico, and so on.

The exercises are carefully graduated, and, on the whole, are well calculated to stimulate the pupil's interest. Here and there the text needs a little revision. Thus the experiment (3) on p. 45 is meaningless as it stands. A weighed quantity of household "blue" is mixed with water, the mixture evaporated to dryness, and weighed. The student is then asked to state the percentage of "blue" dissolved! Again (p. 59), permanently "hard" water is directed to be made by dissolving *common salt* in distilled water. Then, after the naïve remark that "we have used salt because it is convenient," the pupil is taught how to "soften" (such) permanently hard water by means of washing-soda. These exercises should be revised; they do not bring out the essential fact that it is the soluble salts of calcium and magnesium, not those of sodium, that cause permanent hardness. "Of the nitrogenous foods there are protein, water, and salts" (p. 70) is a cryptic saying; and it is not the only one. The impression given is that the author occasionally gets a little out of her depth; but the book as a whole will be found quite useful and convenient.

(6) At first sight the title "Acids, Alkalis, and Salts" appears rather unattractive—except perhaps to the chemist, who knows these products already. Mr. Adlam, however, manages to make quite a readable little volume on the subject. Many valuable works will, alas! always and necessarily be classed with the "books that are no books," since they must give the dry bones of facts, and no space is available for investing these facts with even a bare minimum of literary covering. This book, however, aims at being not only instructive, but also interesting. Though starting with little or no knowledge of chemistry, the general reader will have no difficulty in understanding the text, and will find in it a store of information concerning the acids and alkalis which is none the less trustworthy because it is easily and pleasantly acquired. The book may, in fact, be looked upon as a simple introduction to the subject of industrial chemistry. Incidentally, it may help to prevent other people following the example of the man mentioned by the author, who took his son to the Royal School of Mines to "learn copper," and not to waste his time over other parts of chemistry, because "they would be of no use to him." C. S.

Our Bookshelf.

Die Gliederung der Australischen Sprachen: Geographische, bibliographische, linguistische Grundzüge der Erforschung der australischen Sprachen. By P. W. Schmidt. Pp. xvi+299. (St. Gabriel-Mödling bei Wien: *Anthropos*, 1919.)

IN this reprint from *Anthropos* Father Schmidt discusses the structure and classification of the Australian languages. Of these he distinguishes two main divisions, the South Australian and the North Australian. The former comprises the languages of the southern halves of Western and South Australia, of Victoria and New South Wales, and the greater (southern) part of Queensland. The North Australian occupies North-west and Central Australia, the Northern Territory, and Cape York Peninsula. The southern languages are subdivided into twelve groups, the northern into three.

The establishment of the South Australian is based mainly on the likeness of grammar and the occurrence in the languages of similar words for names of parts of the body and personal pronouns. The differences in the various subdivisions are found to run parallel with the sociological grouping. They consist chiefly in the character of the finals, which are vocalic where the purely two-class system and mother-right prevail. In the west, north-east, and centre the finals *l*, *n*, *r* are found with the four-class system, and the two-class system in the south-east is found where the languages have final explosives and double consonants.

The northern languages are similarly grouped according to their final consonants. In the north-west and north, consonantal finals are common, around Carpentaria *l*, *n*, and *r* are found as finals, and vocalic endings are common in Central Australia and Cape York Peninsula. But isolated members of the groups are found all over northern Australia.

Father Schmidt's work is a valuable summary and exposition of the tangle of Australian linguistics. But the nature of the material is so uncertain that there will always be a doubt as to whether the similarities of the South Australian languages here formulated may not be due to their geographical contiguity, one language borrowing vocabulary from others, and all alike gradually assuming the same morphological form.

S. H. RAY.

A First Book of School Celebrations. By Dr. F. H. Hayward. Pp. 167. (London: P. S. King and Son, Ltd., 1920.) Price 5*s*.

THIS is a sequel to "The Spiritual Foundations of Reconstruction," and shows in further detail how some of the suggestions of that interesting book will work out in practice. It may be recalled that the authors—Dr. Hayward and Mr. Freeman—there insisted on the obviously sound idea that in school education more should be made of the emotional, artistic, dramatic, and social approach. They believe, indeed, in scientific and historical wall-charts, the gist of which seeps in to the mind through the eye; they believe in lessons that appeal to the reason—the lessons which bear so little fruit that many of us are often inclined to disbelieve in them; but their hope is in a vast extension of the principle already embodied in Empire Day, Shakespeare Day, and St. David's Day celebrations. Dr. Hayward looks forward in the present book to a national school liturgy of the Bible, literature, music, and ceremonial. The ceremonials would be predominantly oral rather than visual, consisting largely of reading and recitation, song and story; they will be memorial, expository, seasonal, and ethical. It must not be supposed that the author's suggestions depreciate the appeal to reason or propose to codify the emotions; what is suggested is wise and well thought out. We know a little about schools, and our conviction is that the methods suggested would grip in a way that nothing except the teacher's personal influence has hitherto done. They would grip because they are psychologically sound. The celebrations outlined are skilfully devised, but individual teachers would of course vary them. They deal with Shakespeare, the League of Nations, Democracy, St. Paul, bards and seers, world conquerors, Samson, eugenics, temperance, commerce, summer, flying, Chaucer, Spenser. The author has made a notable contribution to the experimental study of education. To test the value of this contribution is an urgent duty, for the school is not very perfect as it is.

New Zealand Plants and their Story. By Dr. L. Cockayne. Second edition, rewritten and enlarged. (New Zealand Board of Science and Art. Manual No. 1.) Pp. xv+248. (Wellington, N.Z.: Dominion Museum, 1919.) Price 7*s*. 6*d*.

THE earlier edition of this book, published in 1910, was described as the first attempt to deal with the plant life of the New Zealand biological region on ecological lines. The second edition is virtually a new book. As an instance, the number of photographs which form so helpful an addition to the text has been increased to ninety-nine, and fifty of these did not appear in the original work. But the author and his subject are the same, and no one is so well qualified to describe New Zealand plant ecology as Dr. Cockayne.

An introductory chapter gives an account of the history of the botanical exploration of the islands from the first visit of Banks and Solander in 1769. Successive chapters are devoted to the various phases of vegetation—the sea-coast, the forests, the grass-lands, high mountains, and others—and a brief account of the vegetation of the outlying islands is given. The author discusses the changes which have taken place in the vegetation since the advent of the British, and strongly opposes the idea that the original New Zealand flora is in danger of being crushed out by European immigrants. On the contrary, practically "no truly

primitive plant formation is desecrated by a single foreign invader." The concluding chapters deal with the division of the islands into botanical districts, and the affinities, origin, and history of the flora. As regards the latter, Dr. Cockayne admits the necessity of great land extension in the Antarctic direction.

Annual Reports on the Progress of Chemistry for 1919. Issued by the Chemical Society. Vol. xvi. Pp. ix+234. (London: Gurney and Jackson, 1920.) Price 4*s.* 6*d.* net.

ONE of the most useful of the publications issued by the Chemical Society is the annual volume summarising the progress made each year in the various main branches of chemistry. With this bird's-eye view of the year's achievements at command, a worker is readily able to survey, in something like proper perspective, the advances made in other divisions of the science as well as in his own.

The period covered by the present volume synchronises with the return of many scientific workers from occupations connected more or less directly with the conduct of war to conditions which, in due time, will no doubt lead to a full resumption of scientific investigation for its own sake. Meanwhile it is too early to expect accounts of many such researches. For the moment, the aftermath of war work is being shown in papers dealing with technical problems on which chemists have worked during the last few years. There is, nevertheless, a fair amount of purely scientific research work recorded. Rutherford's investigations on atomic disintegration are of fundamental importance if the results are eventually confirmed; and other notable pieces of work are the studies on the "poisoning" of palladium as a catalyst by hydrogen sulphide, on the origin of alkaloids from amino-acids, and on fermentation. In the "crystallography" section, it may be noted, a good description is given, with figures, of the principles underlying X-ray methods of exploring crystal structure.

The Ascent of Man: A Handbook to the Cases illustrating the Structure of Man and the Great Apes. (London County Council.) Pp. 74. (London: The Horniman Museum and Library, n.d.) Price 6*d.*

THIS little handbook, by Dr. H. S. Harrison, curator of the Horniman Museum, is written in simple language, and admirably suited to stimulate interest in the recent remarkable progress in our knowledge of the ancestry of man. The bibliography with which it concludes will also be helpful to those who wish to pursue the subject further. Dr. Harrison emphasises the fact that man must be traced back to small arboreal mammals, and well observes: "It is scarcely too much to say that if the earth had borne no trees, there would have been no men." His anatomical descriptions are made readable and interesting by his frequent references to habits and modes of life.

A. S. W.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Relativity and Reality.

No one would wish to strain at a gnat. If the relativist finds it convenient to make the time-axes of his four-dimensional medium the pure imaginary direction by writing $t=\tau\sqrt{(-1)}$, that would appear to be a matter of indifference, so long as for each co-ordinate a single line or axis still suffices to indicate the values that x, y, z, and τ can bear. But the matter becomes complicated as soon as we project in oblique directions. Thus take the equations of the "restricted" relativity theory,

$$x=\beta(x'-ut'), \quad t=\beta(t'-ux'), \quad \beta=(1-u^2)^{-\frac{1}{2}},$$

which upon substitution become

$$x=\beta(x'-iu\tau'), \quad \tau=\beta(\tau'+iux'),$$

and these can be written

$$x=x'\cos\theta-\tau'\sin\theta, \quad \tau=x'\sin\theta+\tau'\cos\theta,$$

if $\tan\theta=iu$.

Thus (x, τ) (x', τ') are co-ordinates of the same point projected upon different axes, but not in any real direction. According to this system, A can grasp B's scheme of space-time only when he generalises his own x, y, z, τ, so that each of them stands for an unrestricted complex variable. But such a removal of restriction cannot be pictured without allotting a whole plane to each variable, and that means doubling our whole apparatus of representation and a description of events in terms of not fewer than eight real dimensions. Surely no physicist can be expected to take the system seriously.

The mathematician does not seem to be aware that he is asking one to swallow a camel. Thus in Prof. Eddington's recent book, "Space, Time, and Gravitation," we read (p. 48): "The observer's separation of this continuum into space and time consists in slicing it in some direction . . . clearly the slice may be taken in any direction; there is no question of a true separation and a fictitious separation." But there is the qualification, which surely deserves mention, that every real direction must be excluded, since the angle θ is necessarily imaginary, because β, which is greater than unity, is its cosine. The original passage from (x, t) to (x', t') is real, and we get back to reality by slicing in an imaginary direction with respect to an imaginary axis. The device should be classed with the focoids, those two imaginary points at infinity where any two concentric circles touch. They recall to the mathematician's mind certain algebraic forms, but have no other actuality whatever. The point I would make, however, is this: If this analogy is dropped, the idea of time as a fourth dimension is not in any way advanced by the interpretation of the equations above from the position it has occupied since the days of Lagrange.

R. A. SAMPSON.

Royal Observatory, Edinburgh, July 26.

An Attempt to Detect the Fizeau Effect in an Electron Stream.

WITHOUT in any way touching the theoretical aspect of the case, it seems worth while to put on record the null result of an experiment to see whether the Fizeau effect was present in the case of a beam of light passing along a rapidly moving stream of electrons.

A pair of Jamin plates giving a separation of the

interfering beams of 33 mm. was set up so as to produce achromatic fringes from the light of a mercury-vapour lamp.

Two tubes each about 100 cm. long, with worked glass plates cemented on the ends, were placed parallel, one in each of the interfering beams. Each tube was evacuated, but one contained a glowing cathode and a cylindrical anode which were connected to an alternating source of potential capable of delivering about 20 milliamperes at 100,000 volts, or alternatively 200 milliamperes at 5000 volts, these two potentials corresponding to electron velocities of about 2×10^{10} cm./sec. and 4×10^{9} cm./sec. respectively.

The method of experiment was to produce wide fringes in the observing telescope, and, by means of two tapping switches, to turn on first the filament-heating current and then the applied potential. In no case was any shift or certain broadening of the fringes observed.

The main difficulty in the experiment was the frequent fracture of the necessarily small glass tube employed as the result of the great heat dissipated inside.

R. WHIDDINGTON.

The Physics Laboratories, The University, Leeds.

Plant-life in Cheddar Caves.

WHILE recently visiting the famous caves at Cheddar I noticed small patches of moss-like vegetation growing near the electric lamps used to illuminate the caves. The caves extend a long way into the hillside, and, as the entrances are but small, daylight penetrates into them to a very short distance only. They are lighted by wire filament electric lamps, of which some are hung from the roof, but many are laid upon their sides in the deep natural recesses, and, in order better to illuminate the formation and bring up the beautiful colouring and folding of the stalactites, are provided with reflectors. It was close against some of these lamps that I noticed the patches of vegetation, and they looked so strange that I asked the attendant if they had been placed there as an experiment. His answer was that they had not, and that he himself had noticed them growing near the lamps.

It seems to me to be curious that this vegetation should be flourishing under such absolutely artificial conditions where there is no trace of daylight. How the spores got so far in is also an interesting point, but possibly they were introduced by dirty spades used when the workmen were digging out the latest extension of the caves.

I should be glad to know if this curious phenomenon has been observed before, and what kinds of plant-life succeed in these unnatural conditions. As one of the excursions during the forthcoming meeting of the British Association at Cardiff will be to the Cheddar Caves, perhaps a botanical visitor will identify the growth and communicate his conclusions to NATURE.

LOUGH. PENDRED.

The Diamagnetism of Hydrogen.

IN a letter to NATURE of July 22 (p. 645) Dr. Ashworth discusses the atomic diamagnetism of liquid and gaseous hydrogen on the hypothesis that diamagnetism originates from rotations or oscillations of the paramagnetic atom or molecule. He ignores, however, the case of atomic hydrogen in normally saturated hydrocarbons given in my letter of July 8 (p. 581). The atomic susceptibility of hydrogen in these compounds is *constant and equal to* $-30{\cdot}5\times10^{-7}$ *at room-temperature*. Onnes and Perrier (Proc. Amsterdam Acad., vol. xiv., p. 115, 1911) have shown that the specific susceptibility of liquid hydrogen is -27×10^{-7}, with a probable error of 10 per cent., so that there is little difference between this value for hydrogen at a temperature less than $-253°$ C. and that derived from the hydrocarbons at room-temperature. According to the kinetic hypothesis of Dr. Ashworth, the paramagnetic atom will appear diamagnetic only if its oscillations exceed 130° on either side of the position of rest, and oscillations of this nature (or complete rotations) must be common to all the hydrogen atoms in any normally saturated compound. This, I think, Dr. Ashworth will scarcely admit is plausible.

Moreover, consider the general case of crystallisation of a diamagnetic substance. The specific susceptibility of the liquid may be less than or greater than that of the crystals, but each is diamagnetic (Ishiwara, Science Reports, Tôhoku, vol. iii., p. 303, 1914; Oxley, Phil. Trans. Roy. Soc., vol. ccxiv., A, p. 109, 1914). Therefore the oscillations of the atoms which appear diamagnetic must be at least 130° on either side of the position of rest, even in crystals—a conclusion which is scarcely consistent with the view that crystalline symmetry is in part determined by the electronic configuration of the atom.

A. E. OXLEY.

The British Cotton Industry Research Association, 108 Deansgate, Manchester, July 29.

Loss of Fragrance of Musk Plants.

IT is important to ascertain whether the loss of scent which has been noticed lately in the musk plant (*Mimmulus moschatus*) in certain areas is of general occurrence throughout the country.

There is no doubt that in many cases the descendants of musk plants which used to form such fragrant inhabitants of our cottage windows have lost the power of producing the peculiar musk-like scent. An important character has dropped out of the musk plant's hereditary equipment, and it becomes a matter of interest to know to what extent and in what manner this has come about.

If any plants can be found which still retain the old scent, intercrossing between these and the scentless variety would probably give genetic results of interest.

C. J. BOND.

Fernshaw, Springfield Road, Leicester, July 26.

Meteorological Conditions of an Ice-Cap.

IN NATURE of July 29 Mr. R. M. Deeley criticises Prof. Hobbs's terminology in describing the meteorological conditions of an ice-cap as anticyclonic. He arrives at the conclusion from Prof. Hobbs's statements that low pressure exists at the centre. This is scarcely necessary.

The high pressure of an anticyclone in temperate regions is maintained by the descent of air in the centre drawn from the upper atmosphere; this compensates for the surface outflow due to the disturbing of the geocyclostrophic equilibrium by surface friction. The same conditions, *i.e.* the surface outflow and the central descent of air, exist in Prof. Hobbs's polar ice-cap anticyclone; the only difference is the physical origin.

In stating that the outflow of air over an ice-cap produced a vacuum which was filled by inflowing air from above, Prof. Hobbs was only describing in separate detail what is really a continuous process, no vacuum ever actually existing.

R. F. T. GRANGER.

Lenton Fields, Nottingham, July 30.

The Research Department, Woolwich.

By SIR ROBERT ROBERTSON, K.B.E., F.R.S.

I.

Explosives Section.

THE Research Department at Woolwich has been in existence under various titles since 1900. Prior to 1914 the staff was small; thus for the seven years preceding the war the chemical branch had a staff of eleven chemists only, and the metallurgical branch of four.

The subjects occupying the chemical staff before the war were connected with the stability of explosives, the investigation of new explosives (such as tetryl, for which a manufacturing process was worked out and issued to a Government factory), and research on the properties of explosives and on the means of initiating them in Service components. These researches proved to have a double importance, in that they not only enabled immediate answers to be given to many questions that arose early in the war, when there was no time for prolonged research, but also afforded the staff the training necessary to meet the demands which became urgent on the outbreak of hostilities.

After the beginning of the war the increase in work imperatively demanded a larger staff, and more chemists were appointed, until at the beginning of 1917, the home supply having failed, permission was obtained to withdraw from France members of the Special Brigade, R.E., of whom more than thirty were transferred to the Department. Finally, the chemical staff numbered 107 chemists and physicists distributed in an organisation which had been gradually evolved, comprising sections for dealing with the different classes of work, such as organic chemistry, physical chemistry, analytical and general chemistry, physical investigation, calorimetry, stability, pyrotechny, applications of high explosives, fuse design, and records.

With increasing work and staff, new buildings for explosives investigation became necessary, and new laboratories were erected, including a well-appointed building (Fig. 1) for physico-chemical research, embodying many of the ideas of Prof. Donnan, and a new range of factory buildings and houses for a variety of specialised work. Climatic huts for storage trials under dry and moist conditions, which have always been an important feature of the Department, were increased in number. In the explosives section the laboratories occupy a space of 64,272 sq. ft., and the buildings for experimental work on a larger scale 38,170 sq. ft. The Department's facilities for testing processes evolved in the laboratory on the semi-manufacturing scale have proved of the utmost value, affording confidence as to the practicability of processes on the full scale.

The Research Department acted as a central bureau for explosives research required by the Navy, Army, the Air Service, and the Ministry of Munitions. Many subjects were referred to it by the Ordnance Committee. Its work is embodied in official minutes and in collected researches termed R.D. Reports.

Trinitrotoluene.—One of the first subjects undertaken after the outbreak of war was the provision of an efficient and rapid process for the manufacture of T.N.T., especially without the use of oleum. From the results of a large series of nitrations in the laboratory, a process was evolved characterised by several novel features, and this was put to the proof on the semi-industrial scale, a plant being designed and erected in the Department (Fig. 2) for the nitration on the quarter-ton scale, with appropriate arrangements for the mixing and concentration of acids. This small plant substantiated in a remarkable manner the process evolved from the laboratory work, and from the start turned out T.N.T. of good quality. The scheme of temperature-rise, the composition of the acid mixture, the nitration in cycles, the process of "detoluation," and other features of the process found immediate application in the large Government factories that were designed and erected by Mr. Quinan, and also in numerous private works built at this time.

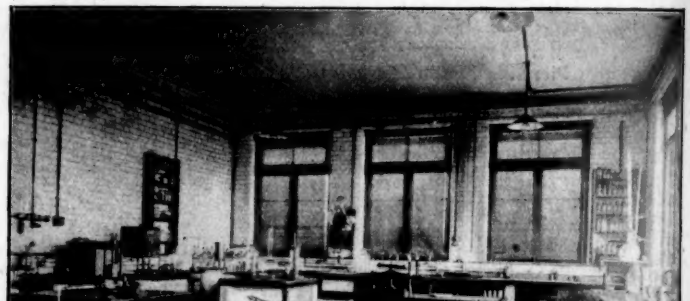

FIG. 1.—A physico-chemical laboratory.

These features have been little altered by later experience. Chemists were trained on this small plant for the purpose of starting Government and private factories, and for a time a few tons a week of the product were purified by alcohol-benzene in another plant erected in the Department to supply the Service with high-grade T.N.T. for exploders.

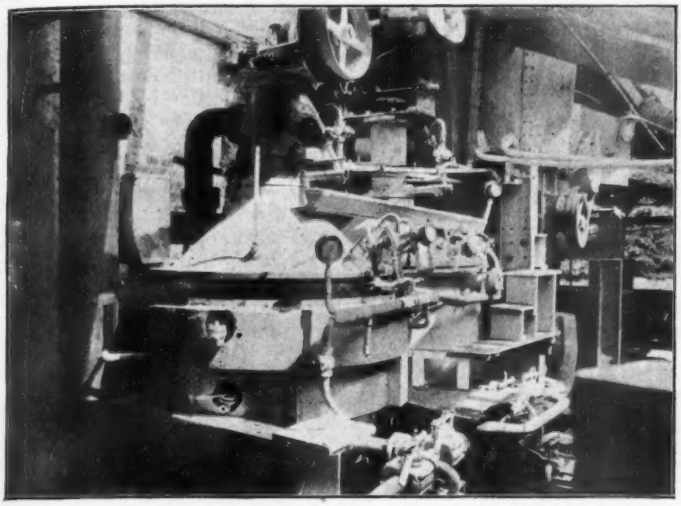

FIG. 2.—Small nitrating plant used to demonstrate the T.N.T. process.

A study of T.N.T. in all its aspects was undertaken. Much attention was given to the chemistry of T.N.T., the proportions in which the isomers occur in the crude product being determined by thermal analysis, and investigations made on their interactions, stability, sensitiveness, heat values, and explosive properties.

Amatol.—As it soon became evident that the supply of the high explosives in use, lyddite and T.N.T., would not suffice, the Department put forward mixtures of ammonium nitrate and T.N.T., the amatols, as a result of study of their properties and of the violence they exhibited in shell-bursting trials. Gun trials substantiated the trials at rest, and their adoption quickly followed. Various methods of filling these mixtures into shell were at this time worked out, many of which have since been applied on the very largest scale.

It was found that 80/20 amatol (80 parts of ammonium nitrate to 20 of T.N.T.) was less easy to bring to detonation than lyddite or T.N.T., and required special arrangements in the train of initiation of detonation. These were successfully devised, and good and trustworthy detonation of our shell was secured. An illustration is here given (Fig. 3) of the fragmentation of an 18-pr. shell filled with 80/20 amatol.

As 80/20 amatol is practically smokeless, the constituents being arranged for complete combustion, mixtures producing a white smoke for indicating the point of burst were worked out for inclusion in the shell-filling. Ultimately, amatol became practically the only explosive for land and aerial warfare, and justified its choice based on the early estimate of its properties and capabilities. In 1917 the production was at the rate of about 4000 tons a week. It is economical in that it makes use of a cheap ingredient, and has explosive properties that render it very suitable for the purposes for which it is used.

The Department continued the study of amatol especially with regard to its chemical stability and compatibility with the various materials with which it came into contact. Certain impurities in ammonium nitrate were discovered to be objectionable, and investigation of this led to an improvement in the purity of the ammonium nitrate supplied.

R.D.B. Cordite.—When the available quantity of acetone became quite inadequate for the cordite required, the Department brought forward a new type of cordite (Research Department "B" or R.D.B. cordite) as a result of experimental incorporations with ingredients chosen to give the same ballistics as ordinary cordite. It could be made with no alteration in the plant required for the manufacture of propellants. Instead of acetone, the solvent employed was ether-alcohol,

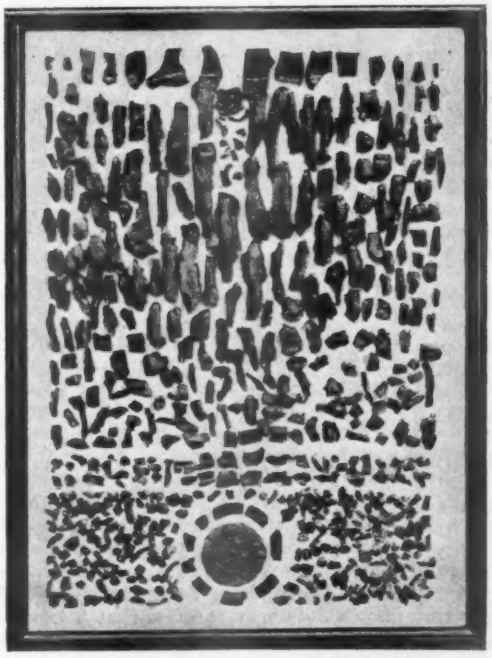

FIG. 3.—Fragmentation of 18-pr. shell by 80/20 amatol.

and instead of gun-cotton, a lower nitrate of cellulose was used. The great factory at Gretna, also built by Mr. Quinan, manufactured R.D.B. cordite exclusively, and this soon became the only propellant made in this country for the Land Service. It was produced both by Government and by private firms in enormous quantities.

The need for ether and alcohol for this propellant led to the restrictions imposed on alcohol.

The recovery of the new solvent presented new problems, and investigations on these were undertaken, which have increased our knowledge of the principles underlying the absorption of vapours.

As difficulties arose in the gelatinisation of the special nitrocellulose required for this powder, the Department continued its studies on the viscosity of cellulose and nitrocellulose with important results, which formed the groundwork of the procedure adopted in supply for obtaining uniformity in the cotton used in the nitration, and a diminished usage of solvent in the incorporation.

Other Explosives.—Many other explosives for special naval and land purposes were put forward by the Department and adopted by the Service after their properties had undergone investigation.

Design of Ammunition.—A feature of the work is the close connection between mechanisms connected with ammunition and the utilisation in them of explosives the properties of which have been found specially suitable. The Department was fortunate in the success which has attended its percussion fuse (No. 106), which played such an important part in the war.

Pyrotechnics.—New demands occasioned by the war led to the study of compositions for pyrotechnic and incendiary purposes and to chemical investigations on the compatibility of the ingredients used. Many new compositions were devised and adopted for signals, stars, and incendiary shell.

Study of the Theory of Explosives.—The study of the chemical constitution of nitro-compounds has been referred to; but a large amount of information the usefulness of which has been reflected on Service requirements has accrued from the development of systematic work on such subjects as the calorimetry of explosives, for which new methods and apparatus have been devised, their sensitiveness, their rates of decomposition and of detonation, and the pressure of the blow they develop. The last was an extension of the work of the late Prof. B. Hopkinson, and has been fruitful in advancing knowledge of theory as well as in providing instruments for quantitative registration of the effects of explosives contained in Service components.

General.—The high quality and efficiency of our ammunition, in spite of shortage and the need for providing substitutes, have been obtained as a result of the continuous application of chemical and physical research. The research initiated and carried out provided in numerous cases methods for the production of explosives, and demonstrated the conditions for their safe employment; principles of fundamental importance were discovered which were utilised in the designing of ammunition; causes of failure at early stages were discovered, thus avoiding unsatisfactory issues of material; and substitutes and alternatives, without which some of our great war manufactures could not have been carried on, were sought and discovered.

(*To be continued.*)

The Earliest Known Land Flora.[1]

By PROF. F. O. BOWER, F.R.S.

II.

COMPARISON of these four fossil species from Rhynie with other fossils already known from the early Devonian period shows that a very homogeneous flora existed at that time, consisting chiefly of leafless and rootless land-living plants. These and other characters, such as their large, distal, sometimes solitary, and often forked sporangia, stamp these plants as exceptionally primitive. Among living plants the nearest of kin to them are clearly the Psilotaceæ, a family which has long presented a problem in morphology and classification. It comprises two living genera, Psilotum and Tmesipteris. Both genera are rootless. Their imperfect morphological differentiation is shown by the fact that botanists are not yet agreed whether their lateral appendages are to be held as truly foliar or not. Psilotum is native throughout the tropics, and is represented by two well-marked species. The commonest, *P. triquetrum*, has upright and shrubby aerial shoots, with radial construction and frequent bifurcations. These spring from leafless underground rhizomes, profusely bifurcated. They are covered with rhizoids, and contain a mycorrhizic fungus. On the lower part of the aerial shoots simple spine-like leaves are borne, but towards the distal ends these are replaced by forked spurs, between the prongs of which a synangium, usually with three loculi, is seated. The aerial shoot is traversed by a vascular strand consisting of xylem in the form of a hollow many-rayed star, with sclerotic core, and branch-strands run out to the appendages. The whole is covered by epidermis with stomata, and the cortex provides the photosynthetic tissue. Tmesipteris is represented by only one species, limited to Australasia. It grows usually among the massed roots that cover the stems of tree-ferns, but sometimes upon the ground. Its general form is like

[1] Discourse delivered at the Royal Institution on Friday, April 30. Continued from p. 684.

that of Psilotum, but the underground rhizomes are longer and the appendages larger, while only two loculi are usually present in each synangium. Clearly the form and vascular structure of these plants are generally like those of the Rhynie flora.

Until quite recently the Psilotaceæ remained the only living Pteridophytes of which the life-cycle was still incompletely known. In all the other groups the regular alternation of two generations had been demonstrated; one is the prothallus, which is sexual, and the other the established plant, which is non-sexual. In the Psilotaceæ also the plant as above described is the non-sexual generation, but hitherto the form or even the existence of the sexual generation remained problematical. Since 1914 the prothalli of both genera of the Psilotaceæ have been discovered, and their structure has been demonstrated by Darnell-Smith, Lawson, and Holloway; and so the very last of these life-histories has now been completed. It turns out that the prothallus of the Psilotaceæ is similar in its general characters to those of other archaic Pteridophytes, being colourless, and living in humus by means of fungal nourishment. In fact, these plants conform in their life-cycle to what is seen in the Lycopods and in the primitive Ferns. Analogy with the living Psilotaceæ makes it highly probable that these early Devonian plants also showed alternation. Though this has not been demonstrated for them, their preservation is so perfect that even the delicate prothallus may yet be revealed as the reward of further search.

The interest of the recent work on the modern Psilotaceæ centres not so much in the details of the prothallus as in their embryology. It has been shown by Holloway that the embryo of Tmesipteris is rootless from the first. This suggests that the rootlessness is primitive, and not the result of reduction. Since the Devonian plants were rootless also, it seems probable that this state was characteristic of such early plants of the land. Further, the existence of Sporogonites, and the very moss-like structure of its sporangium, together with its similarity to the sporangia of Rhynia and Hornea, seem to link up the latter naturally with the Bryophytes, which are also rootless. In fact, we see before us a flora of rootless plants, which raises afresh the question of the first establishment of the neutral generation as an independent, soil-growing organism. It originates in every case within the tissue of the sexual plant, and is at first dependent upon it. This condition is seen in the embryo of Tmesipteris, with details not unlike those of the Anthoceroteæ. How, then, did it first establish itself independently upon the soil?

This question was first raised long ago by Dr. Treub, the brilliant director of the Botanic Gardens at Buitenzorg. He suggested that in the evolution of land-living plants a rootless phase would naturally precede the full establishment of the sporophyte in the soil. He saw this reflected in the embryonic state of certain Lycopods, where a parenchymatous tuber precedes the establishment of the rooted plant. It is attached to the soil by rhizoids, and contains a mycorhizic fungus. This tuber Treub styled the "protocorm." He regarded it as a general precursor of the established leafy plant in descent. During the war new examples of this protocorm-stage were described by Holloway, which show the condition in its most pronounced form. In *Lycopodium laterale* it constitutes the whole plant-body for the first season. It bears numerous protophylls, and may even branch, and reproduce itself vegetatively. It is only later that the leafy shoot and lastly the root are formed. The fact that Hornea shows a similar tuberous swelling at the base of the rootless plant, and retains it even in the adult state, brings the added interest that a permanent protocorm figures in the earliest known land flora. Its antiquity is thus undoubted. But the Devonian plants do not all show it in a distended form. The tuberous swelling is not conspicuous in Rhynia or in Asteroxylon, and it is significant that in the living Tmesipteris the rhizome is cylindrical. These facts indicate that the distended protocorm is neither an obligatory nor a constant feature.

It will not be necessary to do more than refer briefly to the controversy whether the appendages of the Psilotaceæ are truly leaves or branches. The fact suffices that the question has been in debate, and that similar questions arise in relation to these fossils of the Devonian period. In them it is impossible to assign the name "leaf" to any definite part in the full sense in which it is used in the higher vascular plants. The difficulties of their morphological analysis and their rootlessness are in themselves evidence of the primitive state of these fossils. We are, in fact, in the presence of what evolutionists call "synthetic types"—that is, such as link together groups which have diverged. The early Devonian plants and the Psilotaceæ show us just those forms which might have been anticipated as a consequence of comparative study, and some of their characters were actually forecast by Dr. Treub.

Though it may be difficult to place the parts of these synthetic types in the categories of stem, leaf, and root, as those terms are applied to more advanced forms, still they will serve to illuminate the probable origin of these parts. The rhizomes of Asteroxylon suggest an origin of roots from branched, leafless rhizomes. Its "leaves" suggest a relation with the leaves of Lycopods; but its most significant feature is the branch-system ascribed to Asteroxylon, bearing the distal sporangia, which is so like that already described for the enigmatical Carboniferous fossil Stauropteris. This comparison has already been pointed out by Kidston and Lang. On the other hand, approaching the question from the side of the living Ferns, I indicated in 1917 that "the distal and marginal position of a sorus, often monangial, is prevalent among primitive Ferns, and that more complex sori are referable in origin to it." Comparison of the distal sporangia of

the Psilophytales with those of Stauropteris, Botryopteris, the Ophioglossaceæ, Osmunda, and the Schizæaceæ, gives a sequence which sketches in broad lines, though not monophyletically, a probable origin of marginal sporangia for the Ferns. It is accompanied by reduction of size and spore-number in the later and derivative types, which is continued on to the most advanced of living Ferns. A reduction of the distal branchlets to a single plane, and the webbing of them laterally together, would give a type of sporophyll and fructification known in certain primitive Ferns. But if this were the real course of their evolution, the sporophyll so constructed would be a different thing from the "leaves" seen in Asteroxylon. This was the vision of the prophetic Lignier, who has not lived to see his ideas tested by these new discoveries. But such comparisons still leave in doubt the origin of the axis in fern-like types. It is not clear yet how near the truth for them my suggestion of 1884 may be: that "the stem and leaf would have originated simultaneously by differentiation of a uniform branch-system into members of two categories." Nevertheless, the important new fact, which now gives reality to this theory, is that a uniform branch-system has been shown to have existed in these early vascular plants. A sympodial development of it, after the manner shown in the leaves of living Ferns, would provide at least one type of foliar appendage, which would bear a relation to the axis similar to that of the pinnæ to the phyllopodium or Pachis of the leaf.[2]

On the other hand, comparison of the Bryophytes will leave little doubt that the sporangium of the Psilophytales and the sporogonium are kindred structures. If this be so, then we shall see linked together by comparison with these new fossils, not only the sporogonia of Bryophytes and the sporangia of Ferns, but even the pollen-sacs and ovules of Flowering Plants. Long ago it was remarked that the widest gap in the sequence of plants was that between the Bryophytes and the Pteridophytes. It is within this gap that the newly discovered fossils take their natural place, acting as synthetic links, and drawing together more closely the whole sequence of land-living, sporangium-bearing plants. We still await with interest the considered comparisons of the authors of these notable memoirs, though they have already pointed out several fertile lines. But those who have been deeply engaged in comparative morphology may be excused for stating how these new facts strike them. Clearly the morphology of land-living plants is again in the melting-pot. It will emerge strengthened by new and positive facts, and refined by comparisons which can now be based upon solid data, and less than before on mere surmise.

The new facts are thus seen to link the Bryophytes and the Pteridophytes more closely together than ever before. It may be that these two great phyla of land-living plants have themselves diverged from some common source still unknown. But that source is reflected more nearly in these early Devonian plants than in any other known forms. If that be so, whence may these still more primitive plants have sprung? The view has always been entertained that the Algæ preceded land-living plants. For long the fresh-water green Algæ were believed to have provided the source. Latterly from the Continent, but notably also here at home, at the instance of Lang and of Church, the belief has swung round towards marine forms. Highly specialised Algæ flourish on every rocky shore. Some of these show alternation. All are rootless. Some have a differentiation of their branch-system which prefigures the relation of leaf and axis. Not a few of the Red Seaweeds have spore-tetrads borne internally, and located in the ends of specialised branches called stichidia. These are not altogether unlike sporogonia, or the large sporangia of the early Devonian plants. We may well regard it as improbable that any direct transition of such specialised types to a land-habit took place, though this has been hinted at more than once. But at least corresponding features of external differentiation and of spore-production are present in both. Homoplasy may be the real explanation of the likeness, but still the similarity exists.

From what has been said it is clear that during the years of war plant morphology entered upon a new phase. The problems of origin of root and axis and leaf and sporangium have been propounded afresh in terms of the new discoveries. The day is past of that vague surmise on these points which bulked so largely in the discussions of recent decades. It was the paucity of facts that kept opinion in suspense, hovering between rival arguments rather than settling on assured data. Looking back upon the history of that branch of botanical science which is called comparative morphology, there is only one period that can rival the years from 1913 to 1920 in point of positive advance. It is the period which led up to the great generalisations of Hofmeister sixty years ago. In the glories of that work Britain had no direct share, though it was carried out at the very time when Lyell, Darwin, Wallace, Hooker, and Huxley were laying the theoretical foundations which gave their real significance to the discoveries then made by Hofmeister. In the words of Sachs: "When Darwin's theory was given to the world—the theory of Descent had only to accept what genetic morphology had already brought to view." Science, it is true, is cosmopolitan, and should always be held as such. But still we in Britain may feel a legitimate satisfaction that in these recent discoveries, which have transformed the problems of morphology, the material, the observations, and the arguments based upon them are mainly of British origin. The channel of publication of the results, so largely derived by Scottish workers from Scottish material, has naturally been the Transactions of the Royal Society of Edinburgh.

[2] Phil. Trans., 1884, p. 565.

Meteorological Influences of the Sun and the Atlantic.[1]

By PROF. J. W. GREGORY, F.R.S.

THE prospects of long-period weather forecasting and the explanation of major variations of climate appear to rest on two lines of investigation. The effort of the first is to connect changes in the weather with those in oceanic circulation; the second attributes the changes to variations in the heat supply of the sun acting through the atmospheric circulation. Each theory has its own *a priori* probability. The oceanic control of climate has the attraction that each ocean is a potential refrigerator, since it is a reservoir of almost ice-cold water, which, if raised to the surface, must chill the air, disturb the winds, and enable polar ice to drift further into the temperate seas. Hence Meinardus, for example, connected the range of ice in the Icelandic seas and harvests in Germany with variations in the surface waters of the North Atlantic. The alternative theory has the recommendation that, since the earth receives its heat supply from the sun, variation in solar activity is the natural cause of climatic change.

The oceanic theory must be true in part. The abnormal character of some coastal climates is clearly due to the upwelling of cold water under the influence of off-shore winds. Moreover, unusual spells of weather on some of the coasts and islands of the Atlantic follow changes in the quality of its surface water, as proved by Dr. H. N. Dickson for North-western Europe, and by Prof. H. H. Hildebrandsson's demonstration that for fifteen years there has been constant coincidence between rainfall in British Columbia and the weather in the following autumn in the Azores. The alternative theory that the main factor in controlling the temperature of the earth is the varying heat from the sun acting through changes of wind and atmospheric pressure has been mainly advanced by the work of Sir Norman and Dr. W. J. S. Lockyer and of Prof. Frank Bigelow; they are now strongly reinforced by Dr. B. Helland-Hansen, the director of the biological station at Bergen, and Dr. Nansen, who remark that these views have hitherto received but little support.

The important memoir by these Norwegian oceanographers is based on a detailed study of variations in the temperatures of the air and surface waters along the steamer route from the English Channel to New York. Their detailed discussion of the results and associated problems is accompanied by a valuable series of temperature charts of the North Atlantic for the months of February and March from 1898 to 1910. The data are often uncertain. and the inconvenience of the Centigrade thermometer with its zero at freezing point is illustrated by records of water temperature of $-3°$ C. and $-4°$ C., which have to be rejected. Drs. Helland-Hansen and Nansen, after discussion of the theory of oceanic control, reject it as quite inadequate. Thus the chilling effect of the drift of ice into the North Atlantic they estimate as "vanishingly small" in comparison with the heat transported by the air, or even by ocean currents. They consider that, though not yet fully established, the variations of the air temperature preceded, and were therefore not the result of, those of the water temperature. They hold that the variations of temperature require some much greater and more general cause than oceanic variations.

Faith in the meteorological influence of oceanic circulation was greatly favoured by the exaggerated estimates attached to what the authors refer to as "the so-called Gulf Stream." Thus the warmth of the water off the Norwegian coast was attributed to that current even by Pettersson and Meinardus; this conclusion the authors describe as surprising because the evidence of salinity shows that the Norwegian waters are coastal and quite different from those of the mid-Atlantic. This sound criticism of the Swedish and Münster oceanographers renders it the more remarkable that there is no reference, either in the long historical discussion or in the bibliography, to the pioneer work on this subject in the earlier papers by Dr. H. N. Dickson, or to his observations as to the seasonal entrance of the Atlantic water into the North Sea. The authors agree with Schott in terminating the Gulf Stream west of Newfoundland, and calling the current off Western Europe the "Atlantic current," for which Dickson's name of "European current" is more descriptive and definite. The Atlantic is a large mass, and has a whole system of currents, of which the so-called Atlantic current is by no means the largest.

Drs. Helland-Hansen and Nansen, after rejecting the oceanic theory, accept as firmly established the dependence of variations in the earth's temperatures on the solar variations proved by sunspots, the numbers of solar prominences, and terrestrial magnetic disturbances. They point out that the influence of the sun on the weather of any area on the earth depends upon so complex a series of factors that the results at first sight appear inconsistent. The crude expectation that an increase of heat supply from the sun would raise the temperature of the whole earth was early dismissed, for the greater evaporation would lower the temperature on the coastlands by increased clouds, rain, and snow. Blanford pointed out, for example, the see-saw of oceanic and continental conditions; but. though his view has not been fully confirmed, his principle is supported by the proof that regions are oppositely affected by changes in the heat supply from the sun. Bigelow has divided the world into three groups of regions: in the "direct" group the temperature conditions vary directly with the sun; in the

[1] Björn Helland-Hansen and Fridtjof Nansen, "Temperature Variations in the North Atlantic Ocean and in the Atmosphere." Introductory Studies on the Cause of Climatological Variations. Smithsonian Miscellaneous Collections, vol. lxx., Publication 2537. 1920. Pp. viii+408+48 plates.

"indirect" group the variations agree in time, but are opposite in character; in the third, the "indifferent" group, there is no regular correspondence. Sir Norman and Dr. W. J. S. Lockyer have shown that a region may for years belong to the "direct" group, then suddenly become "indirect," and later return to the "direct" group. Drs. Helland-Hansen and Nansen accept this frequent inversion, and also their explanation of the phenomenon.

The authors' instructive study of North Atlantic temperatures therefore strengthens the case for solar variations acting through the atmospheric circulation as the main cause of meteorological changes. To what extent the ocean helps by regulating the air temperature and circulation the authors do not discuss in the present memoir; that and other questions are to be dealt with after further investigations in a series of memoirs to which the present is introductory. The usefulness of the promised memoirs would be increased (should they have as many appendices and supplementary notes as the present) if each were provided with an index.

The Thermionic Valve in Wireless Telegraphy and Telephony.[1]

By PROF. J. A. FLEMING, F.R.S.

THE thermionic valve is an invention which has vastly increased the powers and range of wireless telegraphy. Like many other inventions, the telephone, for instance, it is simple in its essential construction. It consists of a little electric lamp comprising a glass bulb, very highly exhausted of its air, containing a filament of carbon, or better tungsten, which can be rendered incandescent by an electric current. Within the bulb and around the filament are fixed certain metal plates or cylinders, and, it may be, spirals of wire or metal networks called the grid. To explain its origin in its simplest form I shall have to take you back in thought to the days when the physical effects taking place in incandescent electric lamps were first beginning to be considered carefully. In 1883 Mr. Edison for some purpose placed in the glass bulb of one of his carbon filament lamps a metal plate which was carried on a platinum wire sealed through the glass. When the filament was rendered incandescent by a current from a battery, he found that if the plate was connected by a wire, external to the lamp, with the positive terminal of the filament, a small electric current flowed through it, but if connected to the negative terminal no current, or at most a very feeble current, flowed. This new and interesting effect became known as the "Edison effect" in glow lamps, but Mr. Edison gave no explanation of it, and made no practical application of it.

Edison supplied some lamps with plates in the bulb to the late Sir William Preece, and the latter found that the current called the Edison effect current increased very rapidly as the filament was heated to higher and higher temperatures, and that the collecting plate could be placed a long way from the filament, even at the end of a side tube, without altogether causing it to vanish. At a little later date I took up the subject, and one of the first things discovered was that the Edison effect was greatly reduced if that side of the carbon loop filament in connection with the negative pole of the battery was enclosed in a glass or metal tube, or if a sheet of mica was interposed between the filament and the collecting plate. This seemed to indicate that the effect was due to some material emission from the hot filament.

Another fact I observed very soon was that the filament was giving off torrents of negative electricity, and could discharge a positively electrified conductor connected to the plate, but not one negatively charged. Furthermore, I found that the vacuous space between the filament and the plate possessed a curious unilateral electric conductivity for low-voltage direct electric currents, and that even a single cell of a battery could pass a current from the hot filament to the collecting plate if the negative pole of the battery was in connection with the hot filament, but not in the opposite direction. This fact had, however, been previously noticed in another manner by W. Hittorf. These experiments were made in 1888 or 1889, and at that time were not satisfactorily explained.

It was not until nearly ten years later that your distinguished professor of natural philosophy, Sir Joseph Thomson, published accounts of his epoch-making and important researches, in which he proved that the agency we call negative electricity is atomic in structure, and exists in indivisible units now named electrons, which carry a certain electric charge and have a certain mass. These negative electrons are constituents of all chemical atoms. An electrically neutral atom which has lost one or more electrons is called a positive ion, and neutral atoms which have lost or gained electrons are said to be ionised. There are arguments in favour of the view that the majority of the atoms in metals and other good conductors of electricity are in a state of intermittent ionisation, and that intermingled with the atoms or positive ions, say in a wire of copper, tungsten, or carbon, there are electrons which are jumping from atom to atom with great velocity. If we apply to the wire an electromotive force, this causes a drift of these electrons at the instant they are free in the opposite direction to the force (on usual conventions), and this drift or unidirectional motion is superimposed on the irregular motion, and constitutes an electric current. The drift velocity may be very slow compared with the velocity of the irregular motion. The drift motion of the electrons superimposed on the irregular

[1] From a discourse delivered at the Royal Institution on Friday, May 21.

motion may be compared with that of a swarm of bees in which each insect is flying hither and thither rapidly, whilst the whole swarm is being blown by a gentle breeze slowly down a road. If the electrons merely surge to and fro, it gives rise to a form of current we describe as an alternating current, and if they execute this motion very rapidly we call it an electric oscillation.

The reason an electric current produces heat in a conductor is because the drift energy of the electrons is then being continually converted into additional irregular-motion energy in the free electrons and atoms by collisions of electrons with the atoms of the conductor. If, then, the temperature becomes very high—that is, if the irregular electronic motion becomes very great—certain electrons may acquire such velocities that they are flung out from the surface of the wire even against the attraction of the positive atomic ions left behind. If there is no electric force tending to make the electrons move away from the neighbourhood of the hot wire, these electrons constitute a *space charge* around it, and the repulsion they exercise on each other tends to keep other electrons from getting out into the space. Suppose, however, that the incandescent wire is placed in the axis of a highly exhausted glass tube, and is surrounded by a metal cylinder which is kept positively electrified, the electrons move to it, and others then make their exit from the wire. Such a tube with incandescent wire cathode and cold metal plate anode is now called a *thermionic tube*. The steady emission of electrons is called a *thermionic current*. In the case of a tungsten wire brilliantly incandescent *in vacuo* and under sufficient electric force, this current may amount to as much as an ampere per square centimetre of surface. This means that electrons are being flung or pulled out at the rate of millions of billions per second per square centimetre. So soon as Sir Joseph Thomson had proved by experiment that this electronic emission was taking place the explanation of the effects observed in incandescent electric lamps by Edison, Preece, and myself became clear. For in the Edison experiment we have a slow drift of electrons through the carbon filament superimposed on a very rapid and erratic motion, and multitudes of these electrons are escaping from the filament on all sides—just like steam escaping from a porous or leaky canvas steam pipe. If the plate in the bulb is connected to the positive pole of the filament-heating battery, it is positively electrified and it attracts these escaped electrons, and they enter it and drift through the external wire, forming the observed Edison current.

Suppose, then, that we connect the collecting plate by a wire external to the bulb with the negative terminal of the filament, and that we insert in this circuit a battery of a number of cells which can be altered so as to vary the potential of the plate, the said battery having its negative terminal connected to the filament, we then find that a thermionic current flows which can be measured by an amperemeter inserted in the circuit. If we vary the voltage from zero upwards we shall find that the thermionic current increases, but not indefinitely. It soon reaches a value at which no further increase of voltage raises the current. The reason the current does not increase indefinitely is because for each particular temperature of the filament there is a certain maximum possible rate of electronic emission. The electrons are drawn away from the filament at a rate which increases with the potential of the plate up to that point at which the maximum emission rate is reached. The thermionic current then becomes stationary and is said to be *saturated*.

It is remarkable that although this emission of electricity from incandescent substances had been studied for more than a quarter of a century, none of them made any practical application of it prior to 1904. At that date I was so fortunate as to discover a totally unexpected application of this thermionic emission in wireless telegraphy. Before 1904 only three kinds of detector were in practical use in wireless telegraphy, viz. the coherer, or metallic filings detector, the magnetic-wire detector, and the electrolytic detector. The coherer and the electrolytic detectors were both rather troublesome to work with on account of the frequent adjustments required. The magnetic detector was far more satisfactory, and in the form given to it by Senator Marconi is still used. It is not, however, very sensitive, and it requires attention at frequent intervals to wind up the clockwork which drives the moving iron-wire band.

In or about 1904 many wireless telegraphists were seeking for new and improved detectors. I was anxious to find one which, while more sensitive and less capricious than the coherer, could be used to record the signals by optical means. Our electrical instruments for detecting feeble direct or unidirectional currents are vastly more sensitive than any we have for detecting alternating currents. Hence it seemed to me that we should gain a great advantage if we could convert the feeble alternating currents in a wireless aerial into unidirectional currents which could then affect a mirror galvanometer or the more sensitive Einthoven galvanometer. There were already in existence appliances for effecting this conversion when the alternations or frequency was low, namely, one hundred or a few hundred per second. After trying numerous devices my old experiments on the Edison effect came to mind, and the question arose whether a lamp with incandescent filament and metal collecting plate would not provide what was required even for extra high frequency currents, in virtue of the fact that the thermionic emission would discharge the collecting plate instantly when positively, but not when negatively, electrified. Accordingly I appealed to the arbitrament of experiment, and the following arrangement was tried.

Two coils of wire were placed at a distance, and in one of them electric oscillations were created by the discharge of a Leyden jar. The other coil had one terminal connected to the filament of a lamp, and the collecting plate to one terminal of a galvanometer, the second terminal of the latter being connected to the second terminal of the coil. I found, to my delight, that my anticipations were correct, and that electric oscillations created in the second coil by induction from the first were rectified or converted into unidirectional gushes of electricity which acted upon and deflected the galvanometer.

I therefore named such a lamp with collecting metal plate used for the above purpose an *oscillation valve*, because it acts towards electric currents as a valve in a water-pipe acts towards a current of water. I soon found that for the purposes of wireless telegraphy quite a small low-voltage lamp with a metal cylinder placed round a carbon or metal loop filament was a very effective rectifier, and could be used for converting the feeble alternating currents in a wireless receiving aerial into unidirectional currents capable of affecting a telephone or galvanometer. It was almost immediately adopted in practical wireless telegraphy as a simple and easily managed detector, and the intermittent rectified currents were passed through a telephone. Some time after the introduction of this oscillation valve I found that another

method of employing it as a detector was as follows:

If we connect the plate of the valve with the negative terminal of the filament-heating battery, and insert in that circuit a battery for creating a thermionic current, we can delineate a characteristic curve, as already described, by varying the E.M.F. of the plate circuit battery. That curve has generally some places in it at which the slope changes rather quickly. If we adjust the E.M.F. of the plate battery to work at that point, and then by means of a transformer superimpose a feeble oscillatory E.M.F. derived from a wireless receiving aerial, the thermionic current will oscillate from one value to another, and it is easy to see from the concave form of the characteristic curve that the mean value of this varying thermionic current is greater than the value of the steady thermionic current when the oscillations are not superimposed on the steady or battery voltage. This mode of usage in the case of valves with a certain degree of exhaustion in the bulb gives very great sensitiveness in the detection of radio-signals. It is commonly called the potentiometer method because the extra steady voltage required in the plate circuit is derived by employing a fraction of the voltage of the battery used for incandescing the filament by means of a potentiometer resistance.

This is, perhaps, the place to refer to another view of the mode in which my valve acts even when no additional E.M.F. is placed in the plate circuit. The characteristic curve of a valve is found not to start exactly from the point of zero voltage, but from a point on the negative side about ¾ to 1 volt. This means that if the plate is connected to the negative terminal of a filament battery by a wire, there is found to be in it a small negative electric current flowing from the plate through the external circuit to the negative terminal. The reason probably is that the electrons are shot out of the filament with a certain velocity and accumulate round the plate. The result is a tendency for them to diffuse back through the external circuit, creating a feeble electron current which can be stopped only by introducing a small counter E.M.F. into that circuit. Hence the characteristic curve starts from a negative point on the voltage axis. At the place where it crosses the zero voltage point that curve is concave upwards, and hence, for the reason just explained, the introduction into the external thermionic circuit of a feeble alternating high frequency electromotive force will result in an increase in the mean or average thermionic current. Hence the valve is sensitive to feeble electric oscillations and rectifies them, not by quite suppressing all current in one direction, but because the thermionic current is greater for a given E.M.F. applied in one direction in the thermionic current than when that E.M.F. is applied in the opposite direction, whilst the mean value of the thermionic current throughout the complete cycle is greater than its value when the alternating E.M.F. is not applied.

We must now turn to consider an improvement which was introduced in 1907 into the thermionic valve, for which credit must be given to Dr. Lee de Forest. He placed a grid or zigzag of wire carried on a separate leading-in wire between the plate and the filament of my valve, and thereby made what is now called a three-electrode valve (Fig. 1).

In modern thermionic devices the grid takes the form of either a spiral wire or else a metallic gauze cylinder, which surrounds the filament without touching it, and is in turn surrounded by the plate or cylinder which does not touch the grid. This addition enables the valve to act as an amplifier of electric oscillations as follows:

Suppose we insert in the external plate circuit a battery B_2 (see Fig. 1) giving an E.M.F., say, of 100 volts, and also a current-measuring instrument A. If the battery has its positive terminal connected to the plate, the stream of electrons emitted by the filament will be drawn to the plate and give a thermionic current of three or four milliamperes if the valve is highly exhausted. This stream of electrons will reach the plate by shooting through the holes or interspaces in the mesh or spiral grid G.

Let us now suppose that we give the grid a small negative charge by a battery B_3. This will cause the electrons coming out of the filament to be partly repelled, and therefore the thermionic current in the plate circuit will be reduced perhaps even to zero. Again, let us give the grid G a small positive charge. This will attract the emitted electrons, and they will shoot through the grid with increased velocity. Therefore the thermionic current will be increased. The important point to notice is that, owing to the small electrical capacity of the grid, and also owing to the high voltage acting in the plate circuit, a very small expenditure of power on the grid circuit will vary or modulate a much larger amount of power in the plate circuit. Just as the pressure of a child's finger on the switch may start or stop an electric

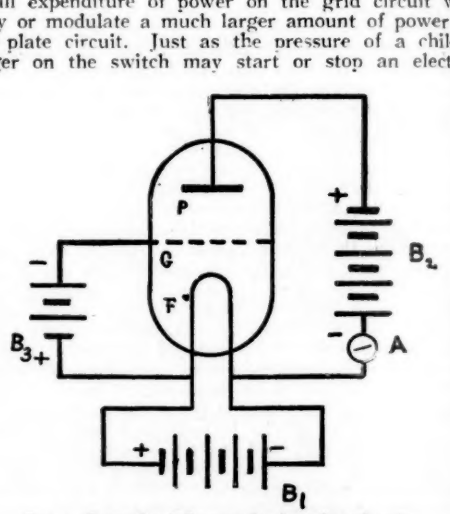

FIG. 1.—Conventional diagram of a three-electrode valve. P, a metal plate or cylinder in a highly exhausted glass bulb. G, a grid or perforated plate or spiral wire. F, the lamp filament. B_1, the filament-heating battery.

motor of several horse-power, or a feeble current passing through a telegraph relay start or stop a large current, so the three-electrode valve acts as a relay.

If we plot a curve delineating the variation of thermionic current with varying grid voltage or potential for such a three-electrode valve, we find that curve over wide limits to be nearly a straight line. This means that the change in plate current is proportional to the change in grid voltage. However rapidly the grid voltage may change, so nimble are these little electrons that the thermionic current copies on a magnified scale the changes of grid potential. Hence the arrangement is called a thermionic amplifier.

We can, however, advance further. If we cause the plate current of one valve to pass through the primary coil of a transformer, and then connect the terminals of the secondary coil of the latter respectively to the grid and filament of a second valve, we find that the fluctuations in the plate current of the first valve can be made to generate exalted potential variations of the second valve, and this again to create magnified variations of the plate current of the second valve. This mode of connection is not limited

to two valves; we can thus employ three, four, or more valves *in cascade*, as it is called, and each one multiplies or amplifies the effect of the one before. It is this use of three-electrode valves in cascade that has given us recently such vastly increased powers of detecting wireless waves. The last or final amplifying valve may be made to operate a detecting or rectifying valve, or perhaps a crystal detector.

But there is an additional very valuable power possessed by the thermionic valve, viz. that it can generate electric oscillations as well as detect them. We have already seen that the fundamental property of this valve is that variations of grid potential create similar variations of plate or thermionic current. Supposing, then, that this latter current is passed through a coil over which is wound another secondary coil connecting the grid and filament (Fig. 2). It is possible so to make the connections that any increase in the plate current will give the grid a negative charge and so immediately reduce the plate current. Conversely, any reduction of plate current will give the grid a positive charge which will again increase the plate current. Hence the operations in the plate current when once started will be maintained, the energy required being drawn from the battery B (see Fig 2) in the plate circuit. The action

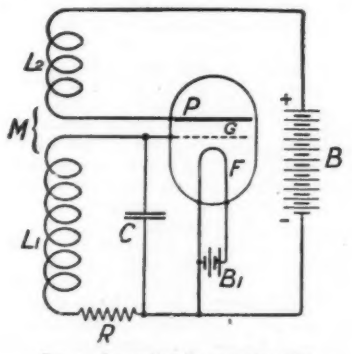

FIG. 2.—Connections for generator valve.

resembles that in the well-known experiment called the singing telephone.

The discovery of the oscillation-producing power of the valve was of great importance, because it at once put it in our power to conduct wireless telephony with simple, easily managed apparatus. The principles of radio-telephony are briefly as follows: At the transmitting station we have to establish in the sending aerial undamped or persistent oscillations and to radiate continuous waves. By means of a carbon microphone we have then to modulate the amplitude or intensity of these waves in accordance with the wave-form of the speaking voice.

The arrangements for a wireless telephone transmitter are, then, as follows: By means of a thermionic valve, with its plate and grid circuit inductively coupled, we set up, as already explained, persistent electric oscillations in the plate circuit, and these are transferred by induction to an aerial wire properly tuned to sympathetic vibration. High frequency electric currents, therefore, flow up and down the aerial. These produce magnetic and electric effects in surrounding space which are propagated outwards as an electromagnetic wave. We have in the next place to vary the amplitude of these radiated electromagnetic waves by a speaking microphone, and this is done by means of a control valve. This latter valve has its grid circuit inductively connected by a transformer with a circuit containing a battery and a telephone transmitter.

Hence, when speech is made to the mouthpiece of the carbon microphone, this varies the electric current through it, and therefore the potential of the grid, in accordance with the wave-form of the speech sound. The plate circuit of this control valve is joined in parallel with that of the generating or power valve, and the result is that speaking to the carbon transmitter modulates the amplitude of the aerial current, and therefore the amplitude of the radiated waves, in accordance with the speech wave-form.

At the receiving station these electromagnetic waves impinge on the receiving aerial and create in it very feeble alternating currents, which are a copy on a reduced scale of those in the transmitting aerial. These are then amplified by valves in cascade, rectified, and sent through a Bell receiving telephone. The result is that the latter emits sounds which closely imitate the speech sounds made to the distant transmitter. We require very high E.M.F. to create a thermionic current of sufficient strength for wireless telephony. This is now obtained by rectifying a high-voltage low-frequency alternating current by a Fleming two-electrode valve.

The whole of the appliances are usually contained in a small cabinet. A ¼-kw. radio-telephone set as made by the Marconi Co. will work over 200 miles and transmit speech perfectly. More powerful arrangements on the same principle have telephoned from Chelmsford to Rome.

For aircraft radio-telephony it is usual to provide a small high-tension dynamo driven by a wind-screw to give the requisite direct high plate voltage. The filament-heating currents are provided from small closed storage cells. The aerial wire is a long trailing wire about 250 ft. in length, which is unwound when required from a drum. The actual valve apparatus may be placed at any convenient place in the aeroplane body and yet be controlled by the pilot or observer from his seat. The mere act of taking hold of the microphone transmitter closes a switch which lights up the valves and throws over the aerial wire into connection with the transmitting valve. Such aircraft radio-telephones will operate over a distance of fifty miles or more. So sensitive are these cascaded valve detectors that it is not even necessary to use a long aerial wire at all. A very few turns of insulated wire wound on a wooden frame, called a frame aerial, connected to the receiver suffice to collect and detect the electric wave signals.

Experiments were conducted in March, 1919, by the Marconi Co. to ascertain the minimum power required to transmit by these valve generators articulate speech across the Atlantic during daylight hours. The transmitting plant consisted of two three-electrode generating valves, with a third control valve for speech modulation. A small alternator of 2·5 kw. power supplied an alternating current which was stepped up in potential to 12,000 volts and rectified by a two-electrode or Fleming valve. The reception was by a series of six valves in cascade, with a final detector valve. The speech transmission was perfectly good and clear across the Atlantic, and so loud at Chelmsford, five hundred miles away from Ballybunnion, Co. Kerry, that it could be heard on a simple frame aerial.

Before leaving the subject of radio-telephony it may be remarked that, both in connection with it and with the everyday uses of radio-telegraphy in maritime intercommunication, there is a great demand for an effective wireless call-bell. I have recently devised a form of call-bell which depends upon the use of a new type of four-electrode valve made as follows: A highly

exhausted glass bulb contains a straight filament of tungsten, which is rendered incandescent by a 6-volt battery. Around the filament are arranged four narrow curved metal plates having their curved sides facing the filament and very near to it. Each of these plates is carried on a wire sealed through the glass bulb. The plates are arranged round the filament, as shown in Fig. 3.

Two of these plates on opposite sides of the filament, viz. 3 and 4 (see Fig. 3), are called the potential plates, and the other two the collecting plates. The collecting plates are joined together outside the bulb and connected to the positive terminal of the filament-heating battery, and a galvanometer G or telegraphic relay is inserted in that circuit. The electronic emission from the filament then creates a current which flows through the galvanometer or the relay, as in the Edison experiment. If the two other plates have a small potential difference made between them, either of constant direction or else a high-frequency alternating difference, this suddenly reduces the thermionic current. The potential difference of the potential plates introduces a new electric force into the field which deflects away the electrons proceeding from the filament and prevents them from reaching the collecting

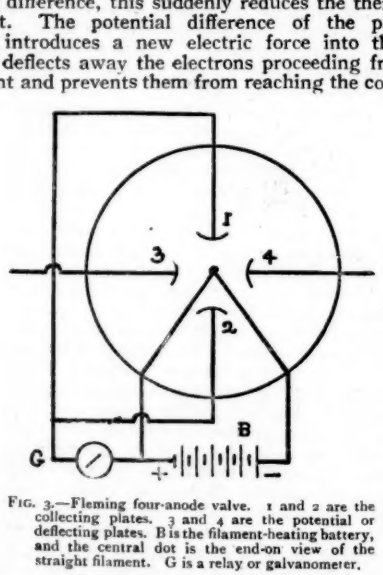

FIG. 3.—Fleming four-anode valve. 1 and 2 are the collecting plates. 3 and 4 are the potential or deflecting plates. B is the filament-heating battery, and the central dot is the end-on view of the straight filament. G is a relay or galvanometer.

plate. If, then, we connect the potential plates to the ends of a resistance of about 15,000 or 20,000 ohms, and include this resistance in the plate circuit of an ordinary three-electrode valve, the thermionic current of the latter flowing through the resistance will create a terminal potential difference which arrests the thermionic current of my new valve. Hence the relay does not operate. If, however, we give an extremely small negative potential to the grid of the three-electrode valve, then this reduces the thermionic current of the latter and increases that of the other valve, which again in turn causes the relay to close contact, and it may be caused thereby to ring a bell. The negative grid potential can be derived from the oscillations in an aerial wire as above described. In this manner I have constructed an arrangement by which the ordinary feeble antenna oscillations can be employed to ring a call-bell. The operator can then switch over the aerial to an ordinary valve receiving set and listen to the telephone.

It remains to say a few words on the methods by which the thermionic valve is employed in the reception of signals made by undamped or continuous waves. By far the best method of receiving signals by these waves is by the so-called beat-reception. If two sets of waves of slightly different wave-length are superimposed, no matter what sort of waves they may be, the result is to produce a compound wave with periodically increasing and decreasing amplitude. These augmentations are called the *beats*.

If a continuous electric wave falls on an aerial it creates on it continuous oscillations. Suppose, then, that we generate also by some local means in the aerial wire undamped oscillations differing in frequency, say by 1000, from the incident waves. The result will be to produce in the aerial electrical beats having a frequency of 1000. These act to a receiver just as do damped trains of waves with a train frequency of 1000. They can be rectified and detected by a valve and telephone, as already explained. It is now quite easy to produce high-frequency oscillations of any required periodicity by coupling a three-electrode valve to the aerial and then coupling the grid and plate circuits of the valve. Sometimes a separate three-electrode valve is used to rectify and detect the beats. Capt. H. J. Round has, however, invented ingenious methods by which one and the same thermionic valve can be used simultaneously to generate and to detect the beats.

We must, in the last place, glance at the uses of the thermionic valve in connection with ordinary telephony with wires. When the rapidly fluctuating electric currents which are propagated when a speaker at one end of a long line converses by telephone with an auditor at the other flow along a copper telephone line, two effects take place which militate against clear and audible speech transmission. First, the current generally is enfeebled as it flows, and this is called the attenuation. Secondly, the different harmonic constituent currents which go to make up the complex wave-form which corresponds to each articulate sound are differently enfeebled.

The vibrations of high pitch are more enfeebled than those of lower pitch. The first effect reduces the loudness of the speech received, and the second its articulate clearness or quality. The cause of the general enfeeblement is the resistance of the line, which fritters away the energy of the speech electric currents. Until lately the only known method of overcoming it was by putting sufficient copper into the line, but this, of course, means cost.

The thermionic valve is, however, able to make a very large economy in copper. It has already been explained that the three-electrode valve can act as an amplifier. Suppose, then, that we cut a long telephone line in the middle and insert on one side a transformer, the secondary terminals of which are connected to the grid and filament of a valve, whilst the plate circuit also contains a battery and a transformer of which the secondary circuit is in connection with the continuation of the line. Feeble telephonic currents arriving at the valve would vary the potential of the grid, and this, as just explained, would fluctuate in like manner, but with increased energy, the plate current. The transformer in the plate circuit would then re-transmit the speech current, but with exalted amplitude. The valve can thus be used to counteract the effect of resistance on the line. In practice, however, the arrangements are a little more complicated, because a telephone line has to be used in both directions.

If our trunk telephone line system in Great Britain had to be laid over again, it is perfectly certain that a very great economy in copper could be made by a widespread use of the thermionic valve as a repeater and relay. It repeats so perfectly that we may certainly say it has completely outclassed all previously invented forms of microphonic relay.

Obituary.

PROF. J. C. F. GUYON.

THE death of Prof. Jean Casmir Félix Guyon, at the end of his eighty-ninth year, removes the last of three famous Paris specialists in genito-urinary surgery; of these Civiale was much the senior, whereas Albarran (1860-1912) was Guyon's brilliant pupil and succeeded him in the professorial chair so far back as 1896. Guyon, though naturally little known to the younger generation of British surgeons, ranks with the late Sir Henry Thompson (1820-1904), with whom professionally he may be compared. Both these pioneers adopted and improved the eminent American surgeon Bigelow's practice of litholapaxy, or the complete removal of all the fragments of a crushed calculus from the urinary bladder at one sitting. Guyon was recognised as a great teacher in his speciality, and for years attracted students from all parts of the world to his clinic at the Necker Hospital.

Guyon was born on July 21, 1831, at St. Denis, in the island of Réunion, and it may be mentioned as a rather curious coincidence that his famous successor, Joaquin Albarran, was also born abroad, namely, in Cuba. Guyon worked first at Nantes and then at Paris, where he was *interne* in 1854 and prosector to the faculty in 1858. His graduation thesis, on "Fibroid Tumours of the Uterus," bears the date 1860; in 1862 he became surgeon to the Paris hospitals, in 1863 *agrégé*, and professor in 1877. His two chief works, "Leçons cliniques sur les maladies des voies urinaires" (1881)—which passed into a second edition in 1885, and a third in two volumes in 1894-96—and "Leçons cliniques sur les affections chirurgicales de la vessie et de la prostate" (1886)—edited by his former resident, Dr. F. P. Guiard—embodied his teaching at the Necker Hospital, and were both translated into German and into Russian. Though famous as a genito-urinary specialist, Guyon took a broad view of surgery, adopted Lister's methods as early as 1876, and was the author of a work of 672 pages on general surgery, dealing with diagnosis and operations in general, entitled "Eléments de chirurgie clinique." Although now somewhat forgotten from his great age and the interval of almost a quarter of a century since he quitted the chair of genito-urinary surgery, Guyon received the honours due to his work and position; he was a Commander of the Legion of Honour, a member of the Institute (Academy of Sciences) and of the Academy of Medicine, and on August 3, 1900, his former pupils, of whom Lucas-Championnière was the senior, presented him with a medal executed by Bottée as a mark of their affection and admiration.

MR. ALEXANDER JAMES MONTGOMERIE BELL, who died on July 3, aged seventy-four, was a fellow of the Geological Society who devoted his leisure for many years to the study of the deposits in southern England in which palæolithic flint implements occur. His researches on the gravels and associated deposits at Wolvercote, near Oxford, were especially valuable, and were described in a paper published in the Geological Society's Journal in 1904. He regarded certain disturbed layers as "ice-drifts," and emphasised the importance of distinguishing "rainwash-drifts" from regular deposits. From an examination of the fossil remains of plants and beetles, he concluded that in late Pleistocene times the climate of the Thames valley was more continental than it is at present. It is understood that Mr. Bell left a general summary of the results of his researches in a manuscript, which we hope may be found in a form suitable for publication.

Notes.

DR. G. C. SIMPSON, F.R.S., Meteorologist to the Government of India, has been appointed Director of the Meteorological Office as successor to Sir Napier Shaw, who retires on reaching the age-limit after brilliant pioneer service. Dr. Simpson was meteorologist and physicist to the British Antarctic Expedition, 1910–13, and served on the Indian Munitions Board from 1917 to 1919. In 1905 he was appointed a Scientific Assistant in the Meteorological Office, and in 1906 joined the staff of the Indian Meteorological Department. He is the author of a number of papers of scientific importance, including one on the electricity of rain and its origin in thunderstorms, published in the Phil. Trans. in 1909. Only last year Dr. Simpson completed an elaborate discussion of the meteorological work of the British Antarctic Expedition, 1910–13. As successor to Sir Napier Shaw his appointment promises a continuation of progress along lines which will advance meteorological science and maintain the high position which the British Meteorological Office now occupies through its work in recent years.

DR. L. V. KING has been appointed Macdonald professor of physics at the Macdonald Physics Building, McGill University. The chair has been held in succession by Prof. H. L. Callendar, Sir Ernest Rutherford, Dr. H. T. Barnes, Prof. H. A. Wilson, and by the present director, Dr. A. S. Eve. Prof. King was born at Toronto, Ontario, in 1886. In 1905 he graduated B.A. at McGill University with first-class honours and gold medal in mathematics and physics. He was elected scholar of Christ's College, Cambridge, in 1906, and appointed lecturer in physics at McGill University in 1910, assistant professor in 1912, and associate professor in 1915, when he also was awarded the D.Sc. degree of McGill University. In 1915 Prof. King began investigations on sub-

marine acoustics for the Electrical and Submarine Committee of the British Board of Inventions. He has been engaged for some time on important researches on the efficiency of fog-signal machinery and on the measurement and distribution of sound.

IN an illuminating article in the *Times* of July 29 Dr. Herbert Levinstein explains the close co-operation of the German Government and the combine of the German aniline dye manufacturers known as the "Interessen Gemeinschaft" or the "I.G.," which enabled the German General Staff to provide large quantities of high explosives and poison gases when the need arose after the Battle of the Marne. Until then the aniline dye factories had not been mobilised; they had continued their ordinary vocation of manufacturing dyes because the great accumulation of high explosives by the Germans had been expected to overwhelm the French in a short time. After the Marne, however, there was an actual shortage of munitions in Germany, and the vast resources of the dye factories were then requisitioned for the production of further quantities of high explosives and of poison gases. Whilst the varied collection of dye-making plant in Germany could be immediately adapted for this purpose, the special plant erected in this country cannot so easily be utilised in the reverse direction, and it is vitally necessary that we should possess extensive plants for the manufacture of dyes comparable with those of the "I.G.," so that not only can the necessary provision be made for any future war, but also facilities for chemical research, which, in chemical warfare and in the dye industry, can be supported only by the industry itself, may be provided to enable us to maintain a premier position.

WE have now had an opportunity of examining at the London office of Messrs. Barr and Stroud, Ltd. (15 Victoria Street, S.W.1), the latest form of that remarkable instrument devised by Dr. E. E. Fournier d'Albe and perfected by Prof. Archibald Barr by which it is possible for a blind man to read ordinary print by listening to sounds in a telephone receiver. The apparatus, which is called the optophone, was fully described by the inventor in an article in NATURE of May 6 last, where the way in which, by the use of selenium cells, a series of distinctive sounds is produced as the "eye" of the instrument passes over the letters was explained. To anyone who has not tested the instrument it is difficult to believe in the possibility of making the sound combinations sufficiently distinctive for even a trained operator, blind or otherwise, to recognise the different letters easily. A few minutes' experimenting, however, is sufficient to dispel all such doubts. After realising the principles of the action, the present writer was, in one or two cases, actually able to name correctly the simpler letters at a first attempt, and there is no doubt that a blind person could be trained to read with the apparatus more easily than he could become expert in picking up a wireless message in Morse. The way in which the letter "w," for example, is represented by beautiful little descending and ascending arpeggios sung softly in one's ear, or a single harmonious chord denotes an "i," is quite fascinating. The adjustments of the apparatus, although delicate, are not beyond the powers of a blind reader of intelligence, and we feel sure that the institutions (including St. Dunstan's and others) which have already acquired these instruments will find them appreciated by the sightless readers whom they train. We have not the space to direct further attention to the numerous little mechanical details which contribute so much to the success of the instrument. It must suffice to say that they are largely the result of long personal attention by Prof. Barr himself, who had at his disposal the unrivalled resources of the well-known firm of range-finder manufacturers.

MAJOR W. E. SIMNETT has retired from the direction and editorship of the *Technical Review* on his appointment to direct the Intelligence Branch of the Ministry of Transport.

THE Harveian oration of the Royal College of Physicians will be delivered by Sir Frederick Andrewes on St. Luke's Day, October 18; the Horace Dobell lecture by Sir William Leishman on November 2; the Bradshaw lecture by Dr. R. C. B. Wall on November 4; and the FitzPatrick lectures on the History of Medicine by Dr. E. G. Browne on November 9 and 11.

ACCORDING to a notice appearing in *La Technique Moderne* for May, a French committee is now engaged in the establishment of an institute for chemical research as applied to industry. The idea is to create, on the model of the Pasteur Institute and the large American research institutes, a powerful scientific organisation at which all kinds of researches of interest to industry may be carried out. In addition to founding the research institute at Paris, the committee intends to provide the means to make grants on a liberal scale to those workers who wish to carry out their work in private laboratories. Missions will also be sent abroad for the purpose of studying conditions there.

THE use of the different species of woods and the preference accorded to the various kinds in industry are determined mainly by experience. In France especially no methodical investigations have hitherto been carried out on the various timbers grown in the country. This want is now to be filled by the enterprise of the Administration des Eaux et Forêts. A series of researches will be undertaken by that Department in consultation with the Technical Section of the Aeronautics Department, dealing with the properties of native woods from the point of view of their utilisation. The first-named Department will collect samples of wood of known origin, and these will be subjected to suitable mechanical tests by the Aeronautics Department. The results of the tests, together with the specimens, will be sent to the research station of the Nancy Forestry School.

AN important discussion on "The Present Position of Vitamines in Clinical Medicine" was opened by Prof. F. Gowland Hopkins at the eighty-eighth annual meeting of the British Medical Association at Cambridge. A full report of the proceedings will be found in the *British Medical Journal* for July 31. Prof. Hopkins said that he deplored the scepticism

concerning the whole question of vitamines which has been displayed by certain members of the medical profession, and gave definite experimental evidence of the effects of deficient diets. The remainder of the paper was devoted to the principal forms of disease which are now recognised as associated with the absence, to a greater or less degree, of one or more of the vitamines from a dietary. The diseases mentioned were scurvy, beri-beri, the xerophthalmia of experimental animals, and rickets. During the discussion which followed further evidence of the importance of vitamines in a normal diet was given by various contributors.

WE have received from Messrs. Flatters and Garnett, Oxford Road, Manchester, a catalogue of mounted microscopical preparations which they are able to supply. The list is a very comprehensive one, ranging from numbers of protozoa, worms, insects, and other invertebrates to vertebrate tissues and structures. Botanical preparations, bacteria, diatoms, petrological specimens, and textile fibres are included, and the firm is also prepared to supply botanical material and pond-life for class purposes. The prices appear very moderate.

IN *Medical Science: Abstracts and Reviews* for July (vol. ii., No. 4) one of the reviews is devoted to the subject of diabetes, and some interesting particulars are given. In the years immediately preceding the war the deaths from diabetes remained constant, whereas during the four years 1916–19 they declined from 444 pre-war to 202. The male sex showed a greater decline than the female, and the percentage mortality among children sank as low as in adults. No case of diabetes was observed as the result of cerebral concussion. These facts give no support to the nervous hypothesis of the causation of diabetes. It is stated that there was a similar diminution in diabetes during the siege of Paris in 1870–71, and during the German occupation of Lille in the late war many of the less severe diabetic cases improved or recovered—probably as a result of the food scarcity.

A CHADWICK lecture on "Health Conditions in Eastern Europe: Typhus a Serious Menace" was given by Dr. Norman White (Medical Commissioner, Typhus Commission, League of Nations) on July 15 at the Surveyors' Institution, Westminster, S.W.1. The countries considered were Latvia, Esthonia, Lithuania, Poland, and the Ukraine. Poland, through which pass the main lines of communication with Russia, has suffered more than her smaller neighbours. Sanitary conditions in this portion of Europe are in a deplorably backward condition, and soap, fuel, and other facilities for cleanliness are unobtainable in many districts, while louse infestation among the poorer classes is almost universal. A large portion of the lecture was devoted to the consideration of typhus fever, the part played by the louse in the conveyance of the disease being described. Emphasis was laid on the danger to other countries arising from the persistence of this focus of epidemic disease. The essential requirements for the anti-typhus campaign were outlined, and the point was made that every country in the world has a very real concern in the existing health conditions of Eastern Europe, apart from humanitarian considerations.

DR. W. CROOKE in the Journal of the Royal Anthropological Institute (vol. xlix., July–December, 1919) discusses the question of "Nudity in India in Custom and Ritual." The present Hindus, like all Orientals, wear scanty clothing, but the rules of decency are generally observed. There are, or were until recently, several degrees of habitual nudity. The earliest stage of clothing seems to have been that of bark, and this and drapery made of sedge and other leaves are still in use in parts of the country. Nudity appears in various magical rites like rain-making, while in the case of some ascetics it implies the renunciation of all family and social obligations. This condition, in the case of rites connected with magic and witchcraft, is fully illustrated, as well as the ætiological legends which have been invented to explain the custom.

IN the Journal of the Royal Anthropological Institute (vol. xlix., July–December, 1919) Mr. Harold Peake discusses "The Finnic Question and some Baltic Problems." Until recent years it was generally supposed that the Finns, like the Lapps and Samoyeds, were an Asiatic people with Mongoloid affinities. On the other hand, Ripley supposes the Finns to be of the Nordic race or closely allied to them, while Ruggeri believes that Proto-Nordics, Proto-Finns, and Proto-Mediterraneans are branches of a common stock which originated on the confines of Europe and Asia. Mr. Peake's conclusion, after a careful review of the evidence from physical anthropology and culture, seems to be that towards the latter half of the third millennium a period of drought occurred in the steppe-lands of the northern hemisphere and caused the Nordic steppe-folk to disperse in various directions. It may be that to this date we must attribute the retreat to the Volga basin which resulted in the hybrid type known as the Red Finns, but the main body seems to have crossed or passed round the plain of North Germany to Denmark, where, perhaps, they met and coalesced with the people of the kitchen-middens; they afterwards passed across the Danish islands to Sweden as the men of the passage-graves, driving before them the Mongoloid aborigines, who had now reached the stage of Arctic culture.

THE lighting of picture-galleries and museums presents problems that have not yet been solved in practice, and especially is this the case with reflections from glass. In the July issue of the *Museums Journal* Mr. Hurst Seager sets forth the scientific principles that are necessary for success. At the recent conference of the Museums Association he gave a brilliant demonstration of their application, and an account of this appears in the August number of the journal. All museum directors should study Mr. Seager's advice, of which the correctness has been proved by a gallery at Wanganui, N.Z. With the July number the *Museums Journal* opened a new volume; with the August number its price is raised to 2*s*.

We have received from the British Association Committee on Zoological Bibliography and Publication recommendations as to the way in which an author should introduce references to previous work quoted by him. Footnotes are condemned. The committee recommends that, at all events in the case of longer articles containing many references, a "list of works referred to," arranged with the names of authors in alphabetical order, should be printed at the beginning or end of each article. In these lists the title of the paper, name of the journal, date, number of series and volume and the pages should be given. It would then, in the text of the article, be necessary to quote only the author's name and the date, with the addition of a page-number where required. The committee also discusses additions to the rules which should be followed when introducing new genera or species in zoological publications.

In the Report of the American Museum of Natural History for 1919 President H. F. Osborn continues his vigorous beating of the educational drum. The museum, he writes, "is actually going backward." Want of space and want of funds prevent the orderly arrangement of the material already accumulated. When the dinosaur rubs shoulders with the mammoth, small wonder that newspaper science represents them as contemporaries. The harmonious development of exhibition galleries is at a standstill. African, Asiatic, Polar, and Oceanic Halls are lacking; for lack of halls of fishes, of reptiles, and of birds of the eastern hemisphere these animals are untruthfully arranged. And the remedy? Extension of the museum on the plan originally intended, partly as a memorial to Theodore Roosevelt, whose connection with zoology is a great asset for more than one museum, and partly by separating the tax rolls and assessments for educational purposes from the general municipal rates and starting a direct poll-tax for education—a tax which would have a basis ten times as broad and would be more willingly paid. It must not be inferred that Dr. Osborn overlooks the research work of the museum, which is the necessary foundation of its educational activities. The team-work on fossil vertebrates accomplished under his guidance by Dr. W. D. Matthew and an accomplished staff is a brilliant witness to the contrary, and the report records a long list of researches and publications in various branches of science. But in New York, as in this country, it is through an appeal to the public on educational grounds that funds can most readily be raised.

Science and Industry for March, the official journal of the Australian Institute of Science and Industry, contains a detailed account of the results of investigations in New South Wales on the extraction of tannins from wattle-bark, which are of great importance to the Australian leather industry. For many years the bark used has been obtained from two species, the golden wattle of South Australia (*Acacia pycnantha*) and the black or green wattle (*A. decurrens*) and its varieties. As a result of the gradual destruction of wattle-trees the Australian supply has been largely supplemented by wattle-bark imported from Natal, where plantations grown from Australian seed have been formed. A valuable tan-bark is also yielded by the mallet (*Eucalyptus occidentalis*) of Western Australia. The faulty methods adopted for the extraction of tannins are criticised, and an improved process is suggested.

In his presidential address to the Linnean Society of New South Wales (abstract of Proceedings, March 31, 1920) Mr. J. J. Fletcher referred to the morphology of the so-called phyllodes characteristic of many of the Australian acacias. According to the definition in text-books, these are the flattened leaf-stalks of bipinnate leaves which have lost their blades, whereas they really represent the primary axes of bipinnate leaves which have lost their pinnæ. Accordingly the name "euphyllode," as implying something more than merely flattened petioles, is proposed for them. The president also referred to the recent costly visitation of drought, and pointed out the need for a handbook or manual setting forth the theoretical complementary side of the practical activities of the man on the land, especially in relation to drought problems. A synopsis indicating the scope and contents of such a handbook was offered for discussion.

Mr. F. Debenham, who accompanied Capt. Scott on his last Antarctic expedition, puts forward (Quart. Journ. Geol. Soc., vol. lxxv., p. 51, 1920) an ingenious suggestion to explain the transfer of marine deposits from the sea-floor to the surface of glacier ice, and so finally to the land when glaciers melt away. A massive glacier protruding seaward may pick up such material by accreting ice along its base. Successive accretions from the freezing sea raise this lower layer until finally it comes to the surface, where ablation is active during summer. It may then be transported to some point impinged on by the ice. The interesting occurrence of sodium sulphate, as mirabilite, in the ice is held to be due to concentration of sea-water in cold sub-glacial lagoons, the water of which has furnished ice, enclosing the separated salt. The case of the Great Salt Lake of Utah, in which sodium sulphate separates when the temperature falls below about 20° F. (−7° C.), is cited as an illustration.

A memorandum regarding the probable amount of monsoon rainfall in 1920 by Dr. Gilbert T. Walker has recently been issued. Data of importance are given showing how the monsoon rainfall in India is affected by previous weather conditions over various parts of the earth. In summing up the effects of the various factors it is mentioned that the prejudicial effect of snowfall from Persia to the Himalayas is exerted when at the beginning of June the accumulations extend over a larger area than usual. The great excess of snow reported this year is confirmed by the low temperatures in the Punjab. Heavy rainfall in South Ceylon, Zanzibar, East Africa, and Seychelles is prejudicial, but data for this year show a moderate deficit or normal conditions. A close relationship exists between heavy rain in Java from October to March and low barometric pressure in Bombay in the succeeding six months; in Java the rainfall was nearly normal and its effect is negligible. High barometric pressure in Argentina and Chile is

a favourable condition, but this year pressure is in slight defect. It is stated that the conditions indicate that in North-West India the monsoon is likely to be weak, at any rate in the earlier part of the season, and for the rainfall of the Peninsula, North-East India, and Burma the indications are not sufficiently definite to justify a forecast.

THE Italian Laboratory of Practical Optics and Mechanics of Precision, which was founded in Florence last year on the suggestion of the Minister of Public Instruction to spread a knowledge of recent advances in instrument-making amongst those engaged in the industry in the country, has undertaken the issue of a monthly *Review of Optics and Mechanics of Precision*. The number for March and April consists of a little more than thirty quarto pages. The first seven are devoted to a continuation of a report by Prof. L. Silberstein on the quantum theory of spectra. The improvements which Sommerfeld has introduced into the theory by ascribing two degrees of freedom to the electron instead of the one degree of Bohr's theory are dealt with. Constructional optics is represented by articles on the calculation of achromatic objectives and on objectives for aerial photography. Metrology gets an article of sixteen pages on measurements of precision in the mechanics workshop by Mr. V. I. N. Williams, of Armstrong, Whitworth's, Manchester. There appears to be no publication in English which serves the same purpose for our own industries that this review does for those of Italy.

THE July issue of *Science Progress* contains a *résumé* by Mr. S. C. Bradford of the theory of the constitution of the atom propounded by Langmuir in the June issue of the Journal of the American Chemical Society last year. Unlike the "sun and planets" theory which has been so successfully developed by Bohr, the new theory assumes the electrons which surround the positive nucleus to be at rest. They form shells around the nucleus, the number in each shell being twice the square of the number of the shell counted from the nucleus. When the number of electrons is insufficient to fill a number of shells, it is the outer shell which is incomplete. In these outer shells there is a tendency for the electrons to form groups of eight or "octets" either amongst themselves or by association with the electrons of other atoms. The chemical properties of the atom depend mainly on the number of electrons in the outer shell not associated together in octets. The properties of hydrogen, helium, neon, lithium, carbon, nitrogen, oxygen, and fluorine, the similarity in the behaviour of CO_2 and N_2O, of CO and N_2, and the difficulties which compounds of nitrogen raise on the usual theory of valency, are all explained in a simple way by the new theory.

IN NATURE of July 8 we gave an account of the work done recently at the National Physical Laboratory. The appearance of the report of the laboratory for the year 1919 enables us to supplement that account by some information as to the progress of the institution as a Government establishment. With regard to buildings, the new control appears to involve exceptional delay. Extensions contemplated in 1918 and urgently needed have been approved by the Research Department, but not yet authorised by the Treasury. In consequence, apparatus already delivered cannot be housed and utilised. The number of posts in each grade of staff has been fixed, and the conditions of service approximate to those in the Civil Service. In special cases, however, promotion by length of service may be departed from, subject to the approval of the Research Department. Industry appears to be claiming many of the staff who have by their past work added materially to the reputation of the Laboratory, and it is of the utmost importance that the most promising of the younger members of the staff should be retained by sufficiently attractive posts. The Research Department has decided that commercial testing is not in future to be a function of the Laboratory.

A REPORT by Prof. J. C. McLennan on sources of helium in the British Empire has recently been issued by the Department of Mines, Canada (Bulletin No. 31). An investigation of the helium content of natural gas supplies was undertaken at the request of the Board of Invention and Research (London) in 1915, and the report embodies the results, which are now published by permission of the Admiralty. It appears that certain natural gases in Canada form the largest source of supply of helium at present known within the Empire. The percentage of helium present was found to range from zero in gases from the Toronto and British Columbia regions up to about 0·33 per cent. in gases from the Blackheath (Ontario) and Bow Island (Alberta) areas. Two methods were used for isolating the helium: (1) Combustion of the gas with oxygen, the resulting water and carbon dioxide being removed by suitable reagents, and the nitrogen and remaining traces of other gases by means of cocoanut charcoal cooled in liquid air; and (2) condensation of the hydrocarbons and other constituents having higher boiling points than helium in a condenser immersed in liquid air, the residue being then purified by means of charcoal as before. Figures of the apparatus employed are given. Methods based upon these processes are indicated for the large-scale manufacture of helium, and it is considered that commercial production of the gas is almost certain to be undertaken.

FROM the Central Scientific Co., Chicago, we have received a copy of its catalogue of apparatus used in chemical, bacteriological, biological, industrial, and soil-testing laboratories. The catalogue is very complete, and it indicates the thorough manner in which American manufacturers have developed the production of scientific apparatus. Practically all the articles described are stated to be "American made," the only important item of foreign manufacture being English (Whatman) filter-paper. Among other matters of interest we note the new "chain" analytical balance, in which the use of a rider and small weights is dispensed with. The finer weighings are obtained by varying the length of a small gold chain attached at one end to the beam of the balance, and at the other to a vernier which slides on a graduated vertical

column, and is operated by a milled head outside the balance-case. It is claimed that in this way the rapidity and accuracy of weighing are much increased.

AMONG the papers read at the annual meeting of the British Pharmaceutical Conference recently held in Liverpool was one by Messrs. Bernard F. Howard and Oliver Chick upon "Some Recent Samples of 'Grey' Cinchona Bark." A "parcel" consisting of 138 bales of South American cinchona bark received in March, 1920, and analysed by the authors, was found to contain 6·302 per cent. of total alkaloid, the bulk being cinchonine, the figure for which was 5·49 per cent. The bark contained only 0·027 per cent. of quinine. Mr. E. M. Holmes, curator of the Pharmaceutical Society's Museum, has examined the bark, and has expressed the opinion that it is the product of one, or possibly more forms of *Cinchona peruviana*, Howard. The large percentage of cinchonine found in the bark is probably due to the elevation at which the trees grow, as this factor, and the accompanying differences of heat and moisture, are known to influence the character of the alkaloids present.

AT the recent annual meeting of the British Pharmaceutical Conference a paper entitled "Cresineol" was contributed by Mr. T. Tusting Cocking, who showed that when oil of eucalyptus and ortho-cresol are mixed heat is evolved, and on cooling a mass of glistening crystals, consisting of an equimolecular combination of cineole and ortho-cresol, is formed. This is a new compound, which has been named "cresineol." It may be recrystallised from various solvents, and forms beautiful white, transparent, prismatic crystals, melting at 55·2° C. and boiling at 185° C. Cresineol is volatile, and possesses a pleasant camphoraceous odour. It is not caustic in its action on the skin, and yet contains 41 per cent. of cresol. Having high germicidal properties, it is likely to prove of great value as an antiseptic for both internal and external application. The fact that a solid compound is formed when oil of eucalyptus and ortho-cresol are mixed can be made use of as a means of determining the amount of cineole in oil of eucalyptus. The method is based on the determination of the freezing point of a mixture of the oil with ortho-cresol; having observed this point, one may read off directly from a curve given by the author the percentage of cineole contained in the oil.

MESSRS. W. HEFFER AND SONS, LTD., Cambridge, have in the press a book by Dr. A. Harker entitled "Notes on Geological Map Reading," the object of which is to teach the student to visualise a geological map as in three dimensions, and to show that the questions which present themselves to the field-geologist reduce to exercises in very elementary geometry. This simplicity is gained by reckoning all slopes and dips as gradients, thus enabling trigonometry and the protractor to be dispensed with. The amount of dip, the thickness of a formation, the throw of a fault, etc., are measured directly upon a contoured geological map by the use of the scale alone.

Our Astronomical Column.

THE HILL OBSERVATORY, SIDMOUTH.—The council of this observatory has just issued its annual report for the year ending June, 1920, and it is satisfactory to note that all instruments and other equipment are in good condition and that the observatory is now in full working order again. The chief work undertaken consists in photographing the spectra of stars down to magnitude 5·30 and classifying them according to Sir Norman Lockyer's scheme of increasing and decreasing temperatures. Spectra are also photographed of nebulæ and other special objects. An interesting addition has recently been made to the regular work of the observatory in the form of a line of investigation suggested by Prof. W. S. Adams. Prof. Adams has found that the relative intensities of certain lines in stellar spectra vary with the absolute magnitude of the star, and thus, provided the apparent magnitudes are known, a fairly simple method is available for the determination of stellar parallaxes. The line intensities referred to are measured by means of a wedge of dark glass specially made for the purpose, the position of the wedge being noted at which the lines are just obliterated. Some encouraging results have been obtained from preliminary work. A party of members of the British Association visited the observatory at the close of the Bournemouth meeting. The party included several eminent astronomers, some of whom have consented to form a research committee, intended to act as an advisory body on all matters connected with the research work of the observatory.

THE INFRA-RED ARC SPECTRA OF SEVEN ELEMENTS.—No. 372 of the Scientific Papers of the U.S. Bureau of Standards gives the results of an investigation on the wave-lengths longer than 5500 Å. in the arc spectra of seven elements made by Messrs. C. C. Kiess and W. F. Meggers. The yellow, red, and infra-red regions of the arc spectrum of titanium, vanadium, chromium, manganese, molybdenum, tungsten, and uranium were photographed with a large concave grating spectrograph. The photographs were made on plates sensitised to these spectral regions by means of pinacyanol and dicyanin dyes. The wave-lengths of more than 2500 spectral lines were measured, extending from the green at 5500 Å. into the infra-red beyond 9700 Å. So far as is known, impurity lines and spurious lines have been eliminated from the wave-length tables. Frequency differences which were suspected of being constant have been found in each of the spectra. Those who are specially interested in this work may obtain a copy of the paper by applying to the Bureau of Standards, Washington.

NEW SOLAR RADIATION STATION IN ARIZONA.—An anonymous benefactor has given funds to the Smithsonian Institution for the establishment of a new solar observing station in the Haqua Hala mountains in the Arizona desert. The site was chosen as "being probably the most consistently cloudless region in the United States." Dr. C. G. Abbot has gone to set up this station, which will duplicate the work that has been done for some years at Calama, Chile; it is stated that the results obtained there are of assistance in predicting the weather and temperature in Argentina. As is well known, Dr. Abbot considers that, besides the 11-year variation, there are irregular changes in the solar radiation from day to day amounting to as much as 5 per cent., which he suggests may be due either to alterations in the circulation in the sun and consequent variation in the amount of hotter matter brought from the interior, or to changes in the transparency of the solar envelopes.

Iron-depositing Bacteria.[1]

THE appeal of the monograph before us, which is one of the Professional Papers issued under the ægis of the United States Geological Survey, will probably be of direct interest only to a comparatively small section of scientific workers. Although there is much to attract the general reader, it is obvious that the work was not initiated with this end in view. It is worthy of note and a sign of the times that the data supplied by the bacteriologists should be used as a serious weapon of offence in attacking a geological problem.

Many changes, due to biological influences, take place on the earth's surface which profoundly modify the constitution of the material which is destined to become the geological strata of the future. A study of these changes will obviously throw light on the causes which have operated in the past to bring the earth's crust into being. We find in Mr. Harder's paper by far the most comprehensive treatment which we have yet seen of the activities of bacteria in effecting chemical changes in various iron compounds which come within the scope of their influence. He has undertaken the task of bringing together in the form of a critical survey the salient facts of our knowledge of the iron bacteria. This subject occupies the first half of the monograph, and is treated by the author with a masterly regard for essentials, and in it is included the results of some of his own observations and experiments on these interesting micro-organisms. It is interesting to note that the same iron bacteria are found in America as in Europe, although there are slight differences in their distribution and numbers. Thus *Spirophyllum ferrugineum* appears to possess a wider distribution than is the case in this country.

In the preface, which is written by Mr. F. L. Ransome, especial attention is directed to the results of Mr. Harder's inquiry into the physiology of the iron bacteria. Hitherto each investigator has assumed that the results claimed by him as a result of his research on the physiology of some particular species held good for all the iron bacteria. Mr. Harder, however, concludes that there are three principal groups of iron-depositing bacteria: (1) A group the members of which precipitate ferric hydroxide from solutions of ferrous bicarbonate. (2) A second group of iron bacteria that does not require ferrous bicarbonate for its vital processes. (3) A third group that attacks iron salts of organic acids, using the organic acid radicles as food and leaving ferric hydroxide, or basic ferric salts that gradually change to ferric hydroxide. We must confess to a scepticism as to the existence of such deep-seated differences among these organisms, and incline to the opinion that the phenomenon of iron-deposition on micro-organisms shows the working of a simple physiological law which operates on all in the same manner. In support we would advance the fact that Spirophyllum and Leptothrix are so closely allied that some have regarded them as pleiomorphic varieties of one and the same organism. They live in the same waters, they reproduce alike, and are in every way similar except in external form; and yet Spirophyllum is stated to be an example of the first group, whilst Leptothrix is relegated to the second group. A more cogent ground for scepticism lies in the fact that other organisms, including some of the algæ and the protozoa, possess the same attraction for iron compounds. Possibly a closer investigation of the *chemico-irritability* of micro-organisms will throw some light on the question.

[1] "Iron depositing Bacteria and their Geologic Relations." By Edmund C. Harder. United States Geological Survey. Professional Paper 113.

We can recommend the second half of the monograph to all who wish concise information from an authoritative source of the iron deposits of the world and of the factors which influence the formation and determine the mode of deposition of the iron precipitations that are taking place at the present day. With one exception iron is the most abundant element in the earth's crust. Iron salts are being constantly decomposed, and the genesis of the active agents which bring about their decomposition is given in detail. A consideration of these agents brings home to us the necessity of studying the life-histories of various micro-organisms in order to understand how the present deposits came into being. To give one example. The most important of the iron deposits is ferric hydroxide, and a study of the conditions of its formation centres largely round the fact that ferrous compounds are soluble in water containing CO_2 in excess. Now, in particular, ferrous bicarbonate percolates upwards in solution, and when it reaches the surface becomes subject to the interplay of forces, both chemical and biological, which determine its subsequent fate. We must refer the reader to the work itself for more precise information regarding the manner in which this fate is determined.

We are also given a very complete account of the various types of ferruginous sedimentary ores, and in each case the intervention of biological agencies, either in the primary or in the secondary *rôle*, as factors in the determination of the final deposition is explained in a comprehensive and accurate manner. Of greatest interest of all is, we consider, the examination of the conditions which determine the formation of bog-iron ore. These are undoubtedly mainly of a biological nature, and deserve more consideration than they have hitherto received. The interest in this ore is enhanced on account of its formation being a possible stepping-stone to the development of limanites and hæmatites, although Mr. Harder himself has not raised the point. In his reference to the ferrous carbonate deposits he does well to speak with reticence of the factors which have brought about their formation; enough evidence, however, is advanced to give pause to those who would eliminate altogether the activities of micro-organisms from the list of active agents which have brought these deposits into being. Again, Mr. Harder makes out a clear case for the intervention of micro-organisms in the formation of some, at any rate, of the iron sulphide deposits. Sulphuretted hydrogen is evolved as a result of the decomposition of animal and vegetable matter by the saprophytic bacteria. The formation of sulphides with iron compounds is the next step, and it is of great interest that we see the process at work at the present day in the development of the "blue mud" of the ocean bottom.

Both biologists and geologists will be grateful to Mr. Harder for the work which he has done in the preparation of this monograph. DAVID ELLIS.

The Association of Technical Institutions.

THE Association of Technical Institutions opened its summer meeting at the University of Cambridge on July 23, with the Marquess of Crewe, the president, in the chair. The meeting was extended over the following day, when the chairman of the council, Mr. Dan Irving, M.P., presided. Papers were submitted on "A National System of Education," by Principal J. C. M. Garnett (Manchester); on "The Necessity for Close Co-operation between Technical Colleges and the Universities," by Principal C. Coles (Cardiff); on "Continuation

Schools and their Relation to Technical Institutes and Colleges," by Principal C. L. Eclair-Heath (Newcastle-upon-Tyne); and on "Local Colleges and Adult Education," by Principal L. Small (Bootle).

The suggestions of Mr. Garnett for the establishment of a national system of education in England during the next ten years are embodied in a pamphlet presented to a meeting of the newly formed Federal Council of Lancashire and Cheshire Teachers' Associations in January last. It is accompanied by an elaborate "flow" diagram showing graphically in colour the various types of scholastic institutions suggested, of which as many as sixteen are depicted, ranging from the elementary school upwards to the university, and dealing with school and university life up to the twenty-fifth year. It is declared that "it is the main business of all education to form in the mind of every person a single wide interest centred in a supreme purpose," and that "it is the subordinate business of education to train young people so that they shall be able to realise their central purpose in some particular form of service to their fellows. For example, the particular form of service for which technical and commercial education prepares is that of providing the material wealth without which no community—so different in this respect from an individual—can make much progress towards the fulfilment of high spiritual purposes." The pamphlet proceeds to divide those who are to occupy the various positions in industry, commerce, and other departments of national life into four classes: Leaders in thought and action, about 3 per cent.; skilled managers and assistants, about 17 per cent.; skilled wage-earners, about 40 per cent.; and unskilled labourers and repetition workers, about 40 per cent.

The scheme suggested received the attention of a meeting, held in June last, of the headmasters of secondary schools in Lancashire, Cheshire, Cumberland, and Westmorland, who expressed strong disapproval of its proposals, which they thought too mechanical, and of the suggestion that there should be lower and higher secondary schools. They were not persuaded that it was desirable to prevent the individual growth and development of each school, and that whilst transference and change of grade seemed to be its keynote, the headmasters believed in elasticity, growth, and continuous development.

The purpose of Mr. Coles's paper is to set forth the present unsatisfactory position of technical institutions in this country, and to propose remedies therefor in respect alike of the development of higher education in technical institutions and of the administration thereof, so as to bring them into closer relation with the work of the universities. Mr. Coles advocates the institution of faculties of technology and commerce in connection therewith, and suggests that an investigation should be set up, as in 1882, into the condition of higher technological education in the United Kingdom.

Mr. Small's paper, accompanied by notes by Principal J. F. Hudson (Huddersfield), deals with local colleges and adult education. The authors advocate the development of the technical institute into "the local college," an official term appearing for the first time in the revised regulations for continuation, technical, and art courses issued by the Board of Education in February, 1917, so that it shall include not only the training of workers in commerce and in specific industries, but also their continued education as citizens by the introduction of humanistic studies, and to provide generally for non-vocational subjects of a literary, scientific, and recreative character, together with facilities for the study by adult workers of questions calculated to promote a better understanding of the character and problems of social life. Already with this end in view the Huddersfield Technical College has entered into close relations with the Yorkshire District Council of the Workers' Educational Association.

Mr. Eclair-Heath in his paper declares that the idea of continuation schools is not new, and instances the excellent example of the Royal Dockyard Schools at Deptford and elsewhere. He says that early vocational education is undesirable, and that the schools should be held apart from works. He favours mixed schools and the introduction of religious instruction, and suggests that there should be set up a system of selection whereby only suitable students should be allowed the privilege of continued education up to eighteen years of age.

Resolutions were adopted welcoming a large development of humane studies in the constituent institutions of the association in connection especially with adult education:—"That the association accepts the description of the work of a 'local college' contained in Appendix III. of the Draft Regulations of the Board of Education for continuation, technical, and art courses in England and Wales"; and "That each local college should be the recognised centre for the organisation of educational courses for adults in its area and for the supply of qualified lecturers and class tutors and adequate library and other facilities." It was resolved to refer to the council the question that the Board of Education should be asked to accept as "recognised service" the services of teachers engaged in organisation, supervision, and inspection with the view of qualifying such persons for pension under the recent Superannuation Act, and that the Board should furnish to every teacher of forty-five years of age and upwards a statement of his position as to the period of "recognised service" and "qualifying service" at present placed against his name for the purpose of pension.

The Asiatic Origin of Man.[1]

THE author of the speculative paper referred to below is an evangelist of the gospel of evolution according to Dr. W. D. Matthew. The idea of the Asiatic origin of the dominant orders of mammals, in its source as old as Buffon, was in 1915 placed on a firm basis by Matthew in his paper "Climate and Evolution." This idea Dr. Griffith Taylor now takes up and applies to the case of man. Penck's fourfold subdivision of the Ice Age is regarded as applying generally, and the development of the prehistoric races in Asia is presumed to occur in the successive mild periods as follows:

Chellian and Acheulian.	Pliocene.
Mousterian.	Gunz-Mindel.
Aurignacian, Solutrean, and Magdalenian.	Mindel-Riss.
Azilian and Neolithic.	Riss-Würm.
Bronze-using Races.	Post-Glacial.
Mongolians.	Late Post-Glacial and Historic.

The following Ice Age in each case and in post-Glacial times the progressive desiccation of Asia are presumed to have caused migration from the homeland to the peripheral continents. The migrations are thus fairly well timed to enable the respective races to keep their appointments in Europe, with, perhaps, the exception of the Chellians, Acheulians, and Mousterians, who are too early, if we may judge

1 "Climatic Cycles and Evolution." By Dr. Griffith Taylor. *Geographical Review*, December, 1919.

by Penck's placing of these culture stages, which, however, rests only on indirect evidence.

Taking as his criteria of evolutionary advance four characters, namely, (1) cephalic index, (2) orbital index, (3) hair section, and, in a modified degree, (4) skin colour, Dr. Griffith Taylor then attempts an analysis of the existing races of mankind, and, so far as the available data permit him, shows that the more primitive races, or those with low cephalic and orbital indices and relatively flattened hair section (generally associated with depth of skin colouring), have been thrust to the more distant parts, from a migrant's point of view, of the outlying continents. Closer in to the centre of distribution come races with successively higher indices, rounder, straighter hair, and reduced colouring, passing through brown, olive, and white to the yellow, brachycephalic, and excessively straight-haired Mongolians, who are the last development of all. So far this is Dr. W. D. Matthew elaborated. A new element is now, however, introduced into the discussion, for an attempt is made to correlate the living with the prehistoric races. One remembers Sollas's tentative comparisons in 1911 ("Ancient Hunters"), viz. Tasmanian with Eolithic or Early Palæolithic, Australian with Mousterian, Bushman with Aurignacian, and Eskimo with Magdalenian. The author now postulates direct descent for these and many other races too numerous to mention here.

To bring out the nature of the climatic impulse that is supposed to have initiated the successive waves of migration from the homeland in Asia, the author employs the analogy of the seasonal oscillation of the belts of tropical rains, desert, and polar rains in Australia. As he effectively remarks, Nature has placed Australia like a blackboard, on which are recorded the results of the mobile but very regular and law-abiding climatic zones of the southern hemisphere. He brings forward evidence to show that these zones underwent an analogous migration during the climatic oscillations of the Ice age.

The analysis outlined above forms parts i.–iii. of the paper. The general exposition of the argument is crude, and, were it not for the explicitness of the diagrams, would be difficult to follow. This tabulating and precise definition of material largely speculative gives an illusory impression of the state of the subject, but, if the reader is not misled by it, it certainly conduces to clearness. The adroit handling of a subject so as to distinguish fact and legitimate inference from mere speculation is the last art of the scientific writer.

The remainder of the paper is devoted to geological speculations of less interest. Part iv. is an exposition of Chamberlin's theory of cyclic change. Chamberlin's writings (1897–1901) on the subject are not, however, quoted, the principal authority relied on being Schuchert (1914). In this section a table of roughly approximate temperatures is given for the periods from the Triassic to the present. That this type of tabulated speculation is dangerous is instanced by the fact that both zoological and botanical evidence show that the temperature of Europe in the Neolithic period was several degrees higher than it is at the present day, instead of 7° F. lower, as stated.

Part v. is an estimate of geological time based on various authorities. The statement is made that "Joly quotes similar figures, indicating about 300,000,000 as the time interval since the same epoch" (the Cambrian). It is difficult to conceive the author's motive, if any, for this implicit misrepresentation of the works cited, for it matters not a straw to his theory whether the interval since the Cambrian is 300,000,000 or less than 100,000,000 years, as concluded by Joly.

Part vi. is a suggestion, on astronomical lines, of rhythmic oscillations of climate, etc. It is on a par with many former theories of the Ice age in assigning a cause which there is no independent evidence to show was ever operative.

Papers such as this which deal in giddy speculation have for some time past been looked at askance by the more puritanically minded of our elder geologists. We are not sure that they deserve the contempt with which they are treated. In this matter, however, there is a golden mean, and we should have preferred to see the present paper made less comprehensive, and the leading subject-matter of human migrations more thoroughly dealt with. It is of no use trying to straighten out the universe in an article.

W. B. WRIGHT.

Long-range Forecasting in Java.

PUBLICATION No. 5, 1919, of the Royal Observatory of Batavia, entitled "Atmospheric Variations of Short and Long Duration in the Malay Archipelago and Neighbouring Regions, and the Possibility to Forecast Them," by Dr. C. Braak, embodies the results of a long investigation into the sequence of rainfall in the equatorial regions east of the Indian Ocean. Three kinds of variation are studied: (1) with periods of one or more years up to and including the sun-spot period, (2) secular variations, and (3) with periods less than a month, comparable with Abbot's short-period solar fluctuations. The variations, the period of which is intermediate between (1) and (3) above, are treated as disturbances of (1). Dr. Braak lays much stress on a three-year period, of the persistence of which he gives plausible, though not quite convincing, examples. He classifies three groups of years, of high barometer, low barometer, and transition (from high to low), but naturally finds a proportion of years not strictly true to any of these types. It is scarcely surprising that he finds in general a correlation between barometric pressure and rainfall. For the east monsoon he finds strong positive correlation between high pressure and drought, and weaker between low pressure and excess of rain. For the west monsoon he finds, with some local exceptions, excess of rain with high barometer, and deficit with low barometer. His problem is thus reduced to the intensity of the correlation and the chances of a correct forecast of the barometer variation. His next step takes into account temperature changes which may be expected to modify pressure conditions, but his result is disappointing. He obtains rules, but their application is so far a failure that they appear to break down most thoroughly in years of drought—that is, when, if correct, they would be most valuable.

Turning to secular variations, he finds no evidence of progressive change in Batavian rainfall; in fact, the only progressive change on which he lays stress is in Batavian air-temperature. Comparison with stations in India, Australia, and other places in the same quarter of the globe provides other types of change, but none agreeing with Batavia, and the question is left unsolved.

There remain the short-period pressure waves. The equatorial manifestations of these he attributes to a kind of surge, caused by the great disturbances in higher latitudes, exercising a sucking influence or its converse, with slight variations of the rainfall, less than 10 per cent. of the normal, the effect of which is to compensate the pressure difference by cooling or heating air probably above the 3000-metre level.

Other variations of rainfall, humidity, and cloudiness he considers to be local, and, on the whole, rejects

the possibility of forecasting any short-period variations in the rainfall. Inasmuch as we are bound to regard the tropics as the first stage in the translation of solar variation into weather, it seems a pity that the result obtained in what is probably the best known region of the tropics in regard to meteorological statistics should appear so meagre and wanting in definiteness. Similar work in temperate regions may well be discouraged, but there is still an enormous mass of data W. W. B.

Insects of Arctic Canada.

THE insects of various orders—as well as a few spiders, mites, and centipedes—collected by members of the recent Canadian Arctic Expedition (1913–18) have been recorded and described in vol. iii. of the Report (Ottawa, 1919–20). The lists contain much information of value to students of zoological geography. Among the Lepidoptera (described by Arthur Gibson) it is interesting to see varieties of such well-known British butterflies as *Pieris napi*, *Papilio machaon*, and *Vanessa antiopa*. Most of the Coleoptera (by J. M. Swaine, H. C. Fall, C. W. Leng, and J. D. Sherman) belong to species already known in North America, and the same remark applies to the bees described by F. W. L. Sladen, who points out that bumble-bees are "particularly well adapted to Arctic conditions," and records the capture of five nearly full-fed Bombus larvæ on Melville Island (75° N. lat.) on June 21, 1916. The sawflies, described by A. G. MacGillivray, are mostly new species, and, as might have been expected, willow feeders. Among the Diptera (by C. P. Alexander, H. G. Dyar, and J. R. Malloch) there are some interesting details of larvæ as well as descriptions and records of flies, which are relatively numerous in species. The occurrence of larvæ of *Oedemagena tarandi*—the warble-fly of the European Reindeer—in Barren-ground Caribou at Bernard Harbour is noteworthy. Mosquitoes of a couple of species of the genus Ædes were observed (and felt) in swarms. As regards wingless parasites, Prof. G. H. F. Nuttall records that head-lice (*Pediculus capitis*) from the Copper Eskimo of Coronation Gulf show no varietal distinction from members of the species found elsewhere. Dr. J. W. Folsom enumerates a dozen species of springtails (Collembola); two only of these are new, but his figures of structural details, drawn carefully from Arctic specimens of common and widespread northern forms, will be welcome to students of this order.

G. H. C.

Earthquake Waves and the Elasticity of the Earth.

DR. C. G. KNOTT delivered a lecture on "Earthquake Waves and the Elasticity of the Earth" before the Geological Society on June 9. He pointed out that seismograph records of the earth-movements due to distant earthquakes proves that an earthquake is the source of two types of wave-motion which pass through the body of the earth, and a third type which passes round the surface of the earth. Before earthquake records were obtained, mathematicians had shown that these three types of wave-motion existed in and over a sphere consisting of elastic solid material. Many volcanic phenomena, however, suggest the quite different conception of a molten interior underlying the solid crust. At first statement these views seem to be antagonistic, but there is no difficulty in reconciling them. Whatever be the nature of the material lying immediately below the accessible crust, it must become at a certain depth a highly heated fairly homogeneous substance behaving like an elastic solid, with two kinds of elasticity giving rise to what are called the compressional and distortional waves. The velocities of these waves are markedly different, being at every depth nearly in the ratio of 1·8 to 1. Both increase steadily within the first thousand miles of descent towards the earth's centre, the compressional wave-velocity ranging from 4·5 miles per second at the surface to 8 miles per second at depths of 1000 miles and more; the corresponding velocities of the distortional wave are 2·5 and 4·3 at the surface and at the 1000-mile depth respectively. At greater depths these high velocities seem to fall off slightly; but the records fail to give us clear information as to velocities at depths greater than about 2500 miles. Down to this depth the earth behaves towards these waves as a highly elastic solid. The elastic constants, which at first increase with depth more rapidly than the density, become proportional to the density, for the velocity of propagation becomes practically steady. About half-way down, however, the material seems to lose its rigidity (in the elastic sense of the term), and viscosity possibly takes its place, so that the distortional wave disappears. In other words, there is a nucleus of about 1600 miles radius which cannot transmit distortional waves. This nucleus is enclosed by a shell of highly elastic material transmitting both compressional and distortional waves exactly like an elastic solid.

University and Educational Intelligence.

ABERDEEN.—Dr. R. D. Lockhart has been appointed a lecturer in anatomy.

It has been decided to institute a full-time lectureship in bacteriology in the department of pathology.

BIRMINGHAM.—It has been decided that the fees payable by new students entering the University next session shall be increased by 25 per cent. The reasons given for the increase are: (1) The great rise in the cost of administration, materials, maintenance, taxation, and the wages of employees; and (2) the necessity for improving the payment of the academic, particularly the non-professorial, staff.

The Vice-Chancellor (Sir Gilbert Barling), according to the *Birmingham Post*, states that "it is absolutely necessary to increase the stipends of the staff for two reasons: the present salaries are quite inadequate to maintain the teachers in a reasonable state of comfort; and, secondly, because without such increase they will be attracted to other places where stipends are more commensurate with their capacity and worth."

CAMBRIDGE.—The Balfour Memorial Fund studentship will be vacant on October 1 next. Applications are invited for it. Candidates should apply by, at latest, September 15 to Prof. J. Stanley Gardiner, Zoological Laboratory, Cambridge.

On July 29 the honorary degree of Doctor of Law was conferred upon Dr. A. L. Lowell, president of Harvard University; Prof. J. J. Abel, professor of pharmacology, Johns Hopkins University; and Prof. H. Cushing, professor of surgery at Harvard University.

OXFORD.—The fear expressed in some quarters that the application by the University for a Government grant would check the liberality of private benefactors has proved to be groundless in at least one con-

spicuous instance. Mr. Walter Morrison, of Balliol College, has just paid to Bodley's librarian the sum of 50,000*l.* for the capital account of the library. No further conditions are annexed to the gift. This is not the only benefaction for which the University is indebted to Mr. Morrison, for some eight years ago he gave 10,000*l.* to each of three funds—one for the readership in Egyptology, another for the promotion of the study of agriculture, and a third towards the establishment of a professors' pension fund.

THE Cairo correspondent of the *Times* announces that the American Presbyterian Board proposes to establish a university at Cairo, and has purchased a fine site for the building. The new University will be composed of five colleges, namely, arts, Oriental languages, teachers, commerce, and agriculture. It is stated that the first of these will be opened in October.

NOTICE is given that, provided sufficient merit be shown, an election to a fellowship in experimental physics or physical chemistry at Trinity College, Dublin, will take place in May, 1921. Candidates must submit papers or theses (published or unpublished) on or before March 25 next. Further particulars may be obtained from the Registrar, Trinity College, Dublin.

ON the occasion of the meeting of the British Association at Cardiff on August 24–28 the University of Wales will confer the honorary degree of D.Sc. upon the following:—Dr. H. F. Osborn, president of the American Museum of Natural History, or, if he is unable to attend, Prof. C. A. Kofoid, University of California; Prof. G. Gilson, University of Louvain, or, if he cannot attend, Dr. C. H. Ostenfeld, University of Copenhagen; Don Gullermo Joaquin de Osma, Madrid; and Prof. Yves-Guyot, Paris.

THE following subjects of wide educational interest are to be discussed at meetings of the Old Students' Association of the Royal College of Science, London, in the autumn:—September 14, Pre-Kensington History of the Royal College of Science and the University Problem in London, Prof. H. E. Armstrong; October 12, The Proposed University of Science and Technology: Can a Useful and Worthy University be based on Pure and Applied Science?, Mr. J. W. Williamson; and November 9, The Nationalisation of Universities, Viscount Haldane.

DR. R. S. CLAY, principal of the Northern Polytechnic Institute, Holloway, London, N.7, informs us that the governors are re-establishing in September the school of rubber technology at this Polytechnic, and that the school will in future be under the directorship of Dr. P. Shidrowitz, well known by his researches and publications on the chemistry and technology of rubber. There will be a day course open only to students who have had a thorough training in chemistry—preferably at one of the universities—and evening classes for those already in the industry. The school will be in close touch with the industry, as it will be under an advisory committee composed of representatives of the manufacturers, growers, dealers, rubber engineers, etc., and will, therefore, afford a sound theoretical and practical training for those proposing to enter a rubber factory.

THE May issue of *School Life*, issued by the U.S. Bureau of Education, shows that there has been a large increase in the demand for collegiate education during the ten years between 1905–6 and 1915–16. The period shows an advance, especially in public institutions, from 258,603 in 1905–6 to 387,106 in 1915–16, being an increase in the case of men of 40·1 per cent., and in that of women of 70 per cent. The number of teachers engaged has also risen from 23,950 to 31,312. The total income of these institutions has grown during this period from 62,499,931 dollars to 133,627,911 dollars, or 113 per cent., made up of students' fees 36,133,969 dollars, productive funds 18,983,868 dollars, United States Government 6,258,931 dollars, State or city 32,204,111 dollars, private benefactions 30,196,006 dollars, and other sources 9,850,326 dollars. The endowment fund increased from 248,430,394 dollars in 1905–6 to 425,245,270 dollars in 1915–16, or 71·2 per cent. A further table shows that during the last three years there has been a general increase of attendance of 25 per cent. at these institutions.

THE activities of the U.S. Department of the Interior (Bureau of Education) include the bi-monthly issue of a journal entitled *School Life*. That of May last is concerned largely with the question of the supply and remuneration of teachers, a problem apparently even more acute in America than in this country, as is instanced by the fact that on a given day in May the School Board Service Division of the Bureau of Education received 436 requests for teachers, with only seven teachers applying for posts. The chief of the Division reports that a year ago there were 14,000 registrations from teachers willing to take positions. A recent canvass of this list showed only about 4000 now available for service. The maximum average annual salary of teachers for any State is 1600 dollars, whilst the minimum is 93 dollars. The journal further deals with the payment of university teachers, and asks the question: Does it pay to be a college professor? The result of a recent inquiry circular sent out by the Bureau, to which more than two-thirds of the colleges and universities returned detailed and accurate answers, was that in privately supported institutions full professors are receiving on the average 2304 dollars per annum, while assistant professors and instructors draw salaries of about 1800 dollars and 1200 dollars respectively. The salaries of professors at State institutions average 3126 dollars, of assistant professors 2100 dollars, and of instructors 1400 dollars. There is an interesting table comparing the salaries in 1919 of professors, assistant professors, and instructors with those of artisans and labourers, much to the advantage of the latter in some cases.

THE development of social activities in the country districts is a problem of the first importance, and in the May issue of the *Journal of the Ministry of Agriculture* there is a most interesting paper entitled "Social Service in Rural Areas." The author, Sir Henry Rew, points out that if we are to maintain our agricultural output we must provide for the recreation of our farm labourers and their families. The conditions of village life, and, indeed, the whole psychology of the village people, have undergone great changes in the last few years. The young men returning from the Army to their native villages have found expression; the economic status of the farm-worker is improved; and, above all, there now exists a definite organisation of the farm-workers. These men are essentially a practical race; their ambitions are not restricted to increased wages; they simply make a reasonable claim that life shall not be merely a weary monotony of toil, but that there shall be opportunities for enjoyment—more than are afforded by the village alehouse. The demand is universal, and must be met without delay. In the Report of the Adult Education Committee it is suggested that every village should be provided with an institute under full public control. This institute should be the centre of all communal activity, educational, social, and recreational.

Societies and Academies.

SYDNEY.

Royal Society of New South Wales, June 2.—Mr. James Nangle, president, in the chair.—H. G. **Smith** and A. R. **Penfold**: The manufacture of thymol, menthone, and menthol from eucalyptus oils. Work was undertaken in order to determine the molecular structure of piperitone, the peppermint ketone of eucalyptus oils. Piperitone is a menthenone with the carbonyl group in the 3 position. When oxidised with ferric chloride in the ordinary way 25 per cent. of thymol was produced. By reducing piperitone with hydrogen in the presence of a nickel catalyst an almost quantitative yield of menthone was obtained, which on further reduction with sodium in aqueous ether produced menthol. The abundance of piperitone obtainable from *Eucalyptus dives* makes this ketone probably the best source for the manufacture of thymol and menthone.—R. H. **Cambage**: A new species of Queensland ironbark. This new eucalyptus comes from about 120 miles westerly from Cairns, in tropical Queensland, and furnishes a good, red timber. It was found growing on granite formation in open forest country, and resembles *E. crebra* in bark and timber, but differs in the shape of buds and fruits, which latter are hemispherical with exserted valves.

Books Received.

The Physical Chemistry of the Metals. By Prof. R. Schenck. Translated and annotated by R. S. Dean. Pp. viii+239. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 22*s*. 6*d*. net.

A Constitution for the Socialist Commonwealth of Great Britain. By Sidney and Beatrice Webb. Pp. xviii+364. (London: Longmans, Green, and Co.) 12*s*. 6*d*. net.

Governors and the Governing of Prime Movers. By Prof. W. Trinks. Pp. xviii+236. (London: Constable and Co., Ltd.) 22*s*. 6*d*. net.

The World Crisis: A Suggested Remedy. By Sir G. Paish. Pp. 30. (London: Benn Bros., Ltd.) 6*d*.

A Manual of the Timbers of the World: Their Characteristics and Uses. By A. L. Howard. Pp. xvi+446. (London: Macmillan and Co., Ltd.) 30*s*. net.

Dead Towns and Living Men: Being Pages from an Antiquary's Notebook. By C. L. Woolley. Pp. viii+259. (London: Oxford University Press.) 12*s*. 6*d*. net.

Le Rythme Universel. Comme base d'une Nouvelle Conception de l'Univers. By Prof. Dr. C. Mereschkovsky. Pp. 48. (Genève et Lyon: Georg & Co.)

Liverpool School of Tropical Medicine. Historical Record, 1898–1920. Pp. viii+103+plates. (Liverpool: University Press.)

General Botany for Universities and Colleges. By Prof. H. D. Densmore. Pp. xii+459. (Boston and London: Ginn and Co.) 12*s*. 6*d*. net.

Internal-Combustion Engines: Their Principles and Application to Automobile, Aircraft, and Marine Purposes. By Lt.-Comdr. W. L. Lind. Pp. v+225. (Boston and London: Ginn and Co.) 10*s*. net.

Types and Breeds of Farm Animals. By Prof. C. S. Plumb. Revised edition. Pp. viii+820. (Boston and London: Ginn and Co.) 16*s*. 6*d*. net.

Geodesy: Including Astronomical Observations, Gravity Measurements, and Method of Least Squares. By Prof. G. L. Hosmer. Pp. xi+368. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 18*s*. 6*d*. net.

Prospecting for Oil and Gas. By L. S. Panyity. Pp. xvii+249. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 18*s*. net.

London County Council. Education Act, 1918. Draft Scheme of the Local Education Authority. Pp. 112. (London: L.C.C. Education Offices.)

Free Will and Destiny. By St. G. Lane-Fox Pitt. Pp. xix+100. (London: Constable and Co., Ltd.) 5*s*.

The Victoria History of the Counties of England. A History of the County of Surrey. Part 1, Geology, by G. W. Lamplugh; Palæontology, by R. Lydekker. Pp. 34. 3*s*. 6*d*. net. Part 2, Botany, edited by W. H. Beeby. Pp. 35–70. 3*s*. 6*d*. net. Part 3, Zoology. Pp. 71–226. 12*s*. 6*d*. net. Part 4, Early Man, by G. Clinch. Pp. 227–54. 2*s*. 6*d*. net. (London: Constable and Co., Ltd.)

La République Argentine: La Mise en Valeur du Pays. By Dr. P. Denis. Pp. 303+vii plates. (Paris: A. Colin.) 14 francs.

A Little Book about Snowdon. By H. V. Davis. Pp. 30. (Crewe: The Author, "Noddfa," Wistaston.) 8*d*.

Canada. Department of Mines. Mines Branch. Graphite. By H. S. Spence. Pp. ix+202+plates. (Ottawa.)

Peetickay: An Essay towards the Abolition of Spelling. By Dr. W. Perrett. Pp. 96. (Cambridge: W. Heffer and Sons, Ltd.) 6*s*. net.

Atomic and Molecular Theory. By D. L. Hammick. Pp. 82. (Winchester: P. and G. Wells.)

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